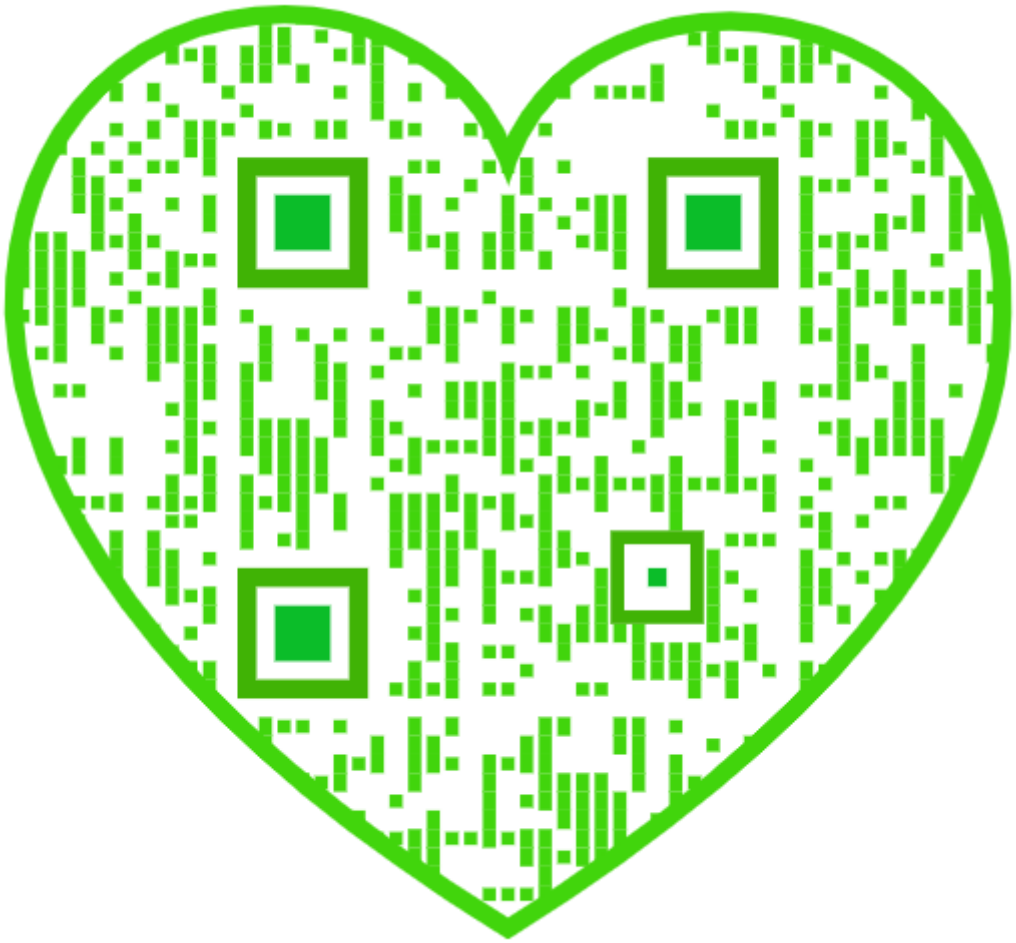

THE

INTERNAL PARASITES

OF OUR

DOMESTICATED ANIMALS;

A

MANUAL OF THE ENTOZOA OF THE OX, SHEEP, DOG, HORSE, PIG, AND CAT.

BY

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PREFACE.

In these pages I have endeavoured to bring to a focus a mass of widely-scattered information, adding thereto a considerable amount of new matter.

It has been thought that a tolerably complete exposition of the curious and intricate subject of parasitism might prove useful, not merely to professional men, but also to sanitarians and others concerned in the administration of public health.

The greater part of the contents of this volume originally appeared in the form of articles contributed to *The Field*.

I have desired that this manual should form a companion volume to my published "Lectures on Practical Helminthology," delivered at the Middlesex Hospital, and likewise that it should supplement my general "Introduction to the Study of Helminthology," a large part of which is devoted to the entozoa of Man.

I have not here attempted to offer more than a

comprehensive outline of the internal parasites of our principal domesticated animals; nevertheless, within the limits prescribed, I believe I have so far covered the whole ground as to present an exhaustive summary of the facts of helminthism.

I indulge the hope that this little volume may not only prove of service to members of the medical and veterinary professions, but also, in a measure, to agriculturists and stockowners, and to other persons more or less interested in the welfare of those quadrupeds that are directly subservient to man's wants. At all events, it was in this latter view that the editor of *The Field* suggested the writing of the original articles.

T. S. C.

84, *Wimpole-street, London,*
September, 1873.

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ERRATA.

At p. 78, top line, *for* "this" *read* "these."
At p. 90, *for* "Estrongylus" *read* "Eustrongylus."
At p. 100, line 12, *for* "have" *read* "I have."
At p. 107, *for* "thearichnidan" *read* "the arachnidan."

THE

INTERNAL PARASITES

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CHAPTER I.

INTRODUCTORY REMARKS—PARASITES OF THE OX—THE HOST—NATURE OF THE SO-CALLED CATTLE PLAGUE BODIES—WHAT ARE FLUKES?—THEIR AFFINITY TO PLANARIANS—GUESTS AND FELLOW-BOARDERS—ENTOZOA ARE NOT THE RESULT OF DISEASED CONDITIONS—TRUE AND FALSE PARASITES—THE COMMON LIVER FLUKE—THE VARIOUS HOSTS IT INFESTS—PRODUCTION OF ROT—PRECAUTIONS SUGGESTED TO VETERINARIANS AND AGRICULTURISTS—FLUKES PREVALENT IN FOREIGN CATTLE.

PEOPLE who are familiar only with certain disagreeable associations connected with the subject of parasites are wont to smile when I assert that an intimate acquaintance with the natural history, habits, and economy of the entozoa, is not merely profitable but pleasant knowledge.

One enthusiastic reviewer, referring to my previously published experiences in respect of the entozoa, sums up

the measure of his admiration of the phenomena of parasitism by frankly saying: "In the life-history of these creatures you are dealing with one of the most interesting and suggestive problems which physiology presents, and you are at the same time contributing to the accomplishment of a task which promises a boon to the human race scarcely second to that conferred by Jenner." He might, perhaps, have appropriately added: If the brute creation could understand and speak, it would, on knowing the ultimate results of the labours of helminthologists, also audibly render its grateful homage.

I shall introduce the subject by some general observations respecting the parasites of the ox.

The ox, considered as a supporter or bearer of parasites, is, like all other animals holding a similar relation, technically and very conveniently termed a *host*. As such he is liable to entertain a great variety of entozoa; and he is frequently also the victim of injurious attacks by several species of insects, which are not entozoa in the zoological sense, though some of them are undoubtedly so in the more general acceptation of that term. Certain of these insects are parasitic both in the adult and larval conditions. The ox, moreover, is the bearer of the juvenile stage of development of an important human parasite; and within the tissues of its body—as obtains also in the case of other food-producing ruminants—we may encounter a multitude of those minute parasitic organisms erroneously called "cattle-plague" bodies.

It would carry me beyond the aim and scope of the present work to give any particular account of these singular organisms; the more so, since they neither belong to the helminths or intestinal worms (as some prefer to call them), nor are they capable of producing

injurious effects on the animals they infest. I may, therefore, dismiss their consideration by referring to my paper "On the Nature of Pseudentozoa found in diseased and healthy cattle," originally published in the *Lancet* for January 1866, and subsequently reprinted in the supplement to my treatise on entozoa, p. 40. The affinity of these bodies to the gregarines and other allied forms of protozoa is there fully explained.

Each species of helminth, entozoon, or true internal animal parasite demands a separate notice; but I shall dwell at more or less considerable length on those forms only which, either by their presence affect the welfare of the beast itself, or prove injurious to mankind indirectly by operating to prevent our utilising the quadruped's flesh as food. On the other hand I cannot allow the short-sighted prejudices of our so-called practical men to prevent my noticing, however briefly, the rarer forms of parasites. For it must be borne in mind that, although in the present state of our knowledge many of the parasites of this animal now seem to be of no practical importance, yet, by-and-by, future discoveries may impart a very different aspect to the value of known facts which, in consequence of this narrowness of vision, have hitherto appeared to be altogether destitute of interest.

In the first place, let us consider the nature of those parasites which are commonly called *flukes*. These creatures form the group or natural order of Entozoa, termed *Trematoda*, or perforated worms. We sometimes speak of them as trematodes, or flounders; but they are recognised more frequently as flukes. A fluke signifies, by virtue of the original meaning of the word, anything flat, and the sailors in the North Seas employ the term "flukes" to designate the flattened division of the tail of the whale.

Flukes are very closely connected, structurally, with a non-parasitic order of small creatures commonly inhabiting ponds and ditches, and which are termed Planarians. Some of these last-named creatures, however, dwell in the sea, attaching themselves to rocks and weeds, crawling about after the fashion of leeches, to which animals they bear a very general resemblance. They rarely measure more than two inches in length.

The planarians so nearly approximate to the common liver-fluke in respect of their digestive organs that it is well to understand this part of their structure. They are extremely voracious, being furnished with a complicated stomachal apparatus. Look, for example, at this

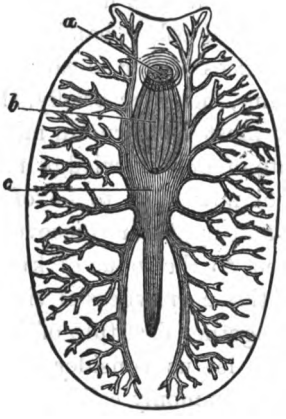

Fig. 1. A PLANARIAN, SHOWING THE DIGESTIVE ORGANS.

illustration of *Eurylepta sanguinolenta* (from Gegenbaur), in which only the alimentary organs are displayed. You perceive a rather large ventrally situated mouth (*a*), leading to a capacious gullet (*b*); whilst from the stomach (*c*) there pass off numerous vessel-like branches, which subsequently divide and subdivide, until at length they

spread themselves throughout the entire substance of the body. I particularly wish it to be understood that the planarians and flukes are destitute of any general somatic or body cavity. The organs in question do not lie loosely in a so-called abdominal space, and for this reason some helminthologists speak of these planarians and flukes as belonging to the parenchymatous or non-cavitary series of worms. The distinction is one of no zoological value; but in relation to the economy of these creatures it is too important to be passed over in silence.

As I have employed the term "host," perhaps it is desirable that I should add that the word "guest," as applied to the entozoon, is equally expressive of the peculiar relation subsisting between the invader and the invaded. Some hosts merely entertain the guests in the capacity of fellow-boarders, in which case the parasites may be looked upon as welcome guests. On the other hand, those entozoa which, like the flukes, remorselessly extract nourishment from the tissues of the bearer must of course be regarded as unwelcome guests.

In whatever way we view this subject of parasitism, the strangest thoughts and reflections are sure to intrude themselves; those especially which have reference to the possible mode or modes of origination of these singular creatures being the most difficult to deal with. Amongst the mazes into which a full consideration of all the facts bearing upon such vexed questions would carry us I do not propose to enter; but I must ask my readers once for all to abandon the erroneous yet very commonly entertained notion, that fluke parasites, as well as other entozoa, are generated as a result of certain diseased or morbid conditions of the tissues of the animal host in which they reside. Not alone by people in general, and by farmers

in particular, is this erroneous conception of cause and effect still maintained, but it is also stoutly contended for by those who ought to know better.

It is desirable that the student of parasitism should clearly understand what sort of creatures ought or ought not to be called parasites. The ideas usually entertained on this subject are altogether vague; consequently, many of the lower forms of animal life are improperly regarded as parasites, when they have no parasitic habits, whilst others again are not looked upon as parasites, though they should unquestionably enjoy this distinction. The fellow-boarders, notwithstanding that they adhere to their bearers, occupy this peculiar position, not for the purpose of "sucking advantage" for themselves at the expense of the larger animal, but for the mutual welfare of either individual. In like manner, a kind of partial parasitism is seen in the case of certain insects, which, merely pay the host a passing visit. No one thinks of speaking of these winged tormentors as parasites; nevertheless, as their attacks are made for the express purpose of acquiring nutriment, they fairly come under the all-embracing title of parasites. I think, therefore, that the term should be made to include all those forms of creatures which in some direct manner derive sustenance by dwelling in or upon—or it might be by merely visiting or instantaneously alighting on the surface of—other living animals.

These few preliminary remarks have appeared to me necessary in view of conveying accurate ideas respecting the essential nature of parasitism. Let me now direct attention to individual examples of bovine parasites, commencing with the common liver fluke.

This parasite (*Fasciola hepatica*) is a rare guest of the ox, being far more abundant in the sheep. It varies in

size from half to rather more than one inch in length, and is sometimes as much as two-thirds of an inch in breadth. If any proof were wanting as to its affinity with the planarians, it is only necessary to look to the arrangement seen in the digestive organs. The present figure, reduced from one by Blanchard, should be compared with that of the planarian. In this illustration *a* refers to the oral sucker, *b* to the bulb of the œsophagus,

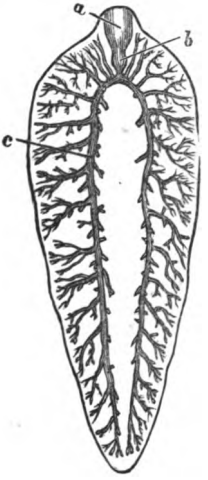

Fig. 2. Common Fluke.

and *c* to the main digestive tube of one side; the other internal organs, as well as the external ventral sucker, being unrepresented.

The common fluke is found in most ruminants, including antelopes and deer; and it has been described as also infesting the horse, ass, hare, rabbit, kangaroo, and beaver. Its alleged presence in the last two quadrupeds requires confirmation; but I can testify to its occasional presence

in the rabbit in great numbers. In some eighteen or twenty instances this parasite has likewise been detected in the human body.

As the ravages of the fluke are chiefly noticeable in the sheep, I shall reserve my account of the "rot" until I treat of the parasites of the sheep. It may be remarked, however, that cattle occasionally suffer from the presence of the liver fluke. Though the disease very rarely shows itself in cattle as an endemic, stockowners will do well to take an opinion where cattle are losing flesh without any very obvious cause.

The veterinarian, when asked to examine a herd, will naturally take into consideration the nature of the soil and locality where the animals are grazing. He will not omit to inspect the fæces in the fresh state; for the presence of a single fluke, or of a few eggs of the parasite, would be likely to point to the true nature of the disorder. It is to be feared that large numbers of cattle are sent to the slaughter-house by stockowners who, observing that the animals are beginning to lose flesh, have a wholesome dread of taking any opinion respecting them, lest the beasts should be condemned as supplying flesh unfit for food. In this matter I sympathise with the owner of cattle. Because a beast loses flesh in consequence of internal parasites of this description, that would not in my judgment be a good reason for condemning the meat as injurious. No doubt, in the case of sheep the flesh is sometimes seriously impoverished; but the watery condition of the muscles and tissues seen in rotten sheep is seldom or never observed in cattle.

In any case the agriculturist will do well to watch the herd closely. If any suspicion of parasitism occurs to him, he will obtain the opinion of a skilled veterinarian.

Only let him take advice in good time; and if flukes be suspected, the necessary indications for checking the disorder are few and simple. If on low grounds, the cattle must be removed to higher or drier pastures. There must be a frequent change of fodder, and the substitution of good manger food for marsh-grown grass. Beans, peas, and fine hay will be particularly suitable. Every kind of palliative treatment should be adopted that would be likely to restore the general health of the animals, or prevent them from receiving fresh attacks. Taken early, there is little need to administer drugs; but the employment of salines will seldom fail to be useful. Even as a means of helping diagnosis, I would suggest the administration of a cathartic, because, if any loose flukes occupy the intestines they are sure to be dislodged, along with a greater or less number of their already discharged eggs.

From personal observation I can testify to the occasional prevalence of flukes in the livers of bullocks destroyed for the markets; and in the report on the parasitic diseases of quadrupeds used for food, issued by the Privy Council in 1865, it is stated by Dr. Thudichum that during his visits to the slaughter-houses in Copenhagen-fields he found "nearly every bullock's liver infected with these parasites." We need not, however, be unduly alarmed at this statement, for I have it on the best authority that the beasts there slaughtered are chiefly derived from foreign sources.

CHAPTER II.

PREVALENCE OF FALSE VIEWS REGARDING THE "ROT DISEASE" — THE LANCET-SHAPED FLUKE — A GOOD TYPE OF THE TREMATODE FAMILY—HAS BEEN KNOWN TO PROVE FATAL TO THE HUMAN BEARER — THE SMALLEST FLUKES MAY PRODUCE DISEASE — ELEPHANTS DIE FROM ROT—THE CONE-SHAPED FLUKE—DEVELOPMENT OF THE AMPHISTOMES — HOW CATTLE BECOME INFESTED—PRACTICAL CONSIDERATIONS—UNDUE NEGLECT OF THIS STUDY ON THE PART OF VETERINARIANS—AMPHISTOMES INFEST RUMINANTS GENERALLY.

As already intimated, I shall have occasion to return to the subject of the ravages produced by this entozoon when I come to speak of the parasites in sheep. I may add, however, that, notwithstanding the clear advances we have made towards an accurate knowledge of the origin, nature, and cause of the fluke disorder, it must be admitted that a great deal remains to be done, whilst it must also be said that very unscientific opinions still prevail throughout the country respecting it. The votaries of experimental research know, by painful experience, how often preconceived notions of the most hollow kind are preferred to healthy deductions based on scientific evidence. It sometimes requires months of precious time spent in research to acquire possession of a single new

fact of any practical importance; and when the dearly-purchased truth is at length enunciated, it is soon bandied about, without the smallest concern respecting either the toiler or the toils which together gave it birth.

There is another little trematode parasite liable to occur in considerable abundance in the ox, but which, on account of its small size, is frequently overlooked. This is the lancet-shaped fluke. When full grown, this species (*Distoma lanceolatum*) measures rather more than three-

Fig. 3. LANCET-SHAPED FLUKE.

eighths of an inch in length, its breadth being somewhat less than two lines. Like most of the flukes, it is a true hermaphrodite, and, as seen in the accompanying figure, also reduced from Blanchard, the transparency of the body readily permits of our recognising the reproductive organs in their natural positions. With the exception of the oral sucker, and the short tube passing from it in a downward direction to form the two simple and blind

intestinal passages, all the organs here represented refer to the system in question. The parasite is shown (Fig. 3) as if viewed from behind, and therefore, as in the previous figure, the so-called ventral sucker has not been traced. It is a true distome, and, as such, forms a very good type of the family.

This elegant little parasite is more frequently found in the ox than in any other host, and has hitherto been observed only in a very limited number of different bearers. It has been detected occasionally in the sheep, and more rarely in the red and fallow deer. If the practical question be asked, "Is it capable of giving rise to disease?" I have no hesitation in replying affirmatively. Not that I am aware of any case of "rot" in bullocks having been recorded as coming from this source, but that I know it has occasioned bad results in the human subject, and I have myself witnessed the most serious disorganisation produced by a species of liver fluke of even smaller dimensions. In my general treatise on Entozoa there is a case, recorded from Leuckart, which is most instructive. The "host" in this instance was a young girl, the daughter of a shepherd, who contracted the disorder while attending her father's sheep. She died from emaciation and an enormously enlarged liver, produced by the action of this parasite. After death it was found that the contracted gall bladder contained forty-seven examples of this worm. If, therefore, disease and death may be occasioned by the *Distoma lanceolatum* in the human subject, it is easy to believe that this parasite must be more or less injurious to cattle and sheep when present in any considerable numbers. As before remarked, I have seen the liver ducts of a non-ruminating animal inflamed and thickened to an extraordinary degree

by the presence of flukes individually of much less size than the species under consideration. It is quite a mistake to suppose that minute parasites are incapable of giving rise to severe disorders. The very reverse is the case. In point of fact, one may almost say that, in particular forms of parasitism, the smaller the parasite, the more likely is its presence liable to give rise to disastrous results.

Since it is now well established that large animals readily succumb to inflammatory disorders occasioned by the presence of flukes, it is clearly our duty to investigate the habits and economy of our rarer as well as of the more common forms of trematode parasites. Only a few years since, I learnt that large numbers of elephants perished from the "rot" in Burmah, and I am indebted to Mr. Thacker, V.S., of the Madras Army, for specimens of the offending entozoon, which I have named *Fasciola Jacksoni*. These parasites were first noticed by Dr. Jackson in the year 1847, and probably the original examples are still preserved in the Boston Museum, U.S. The species is figured in the supplement to my larger treatise (p. 79). I cannot dwell further on the flukes in question, but I prefix these few remarks as a fitting introduction or apology for entering into the consideration of some of the rarer forms of bovine entozoa.

The Cone-shaped Fluke.—This small and rather attractive-looking trematode (*Amphistoma conicum*) dwells in the paunch of cattle. It measures somewhat less than half an inch in length, and scarcely more than one-eighth of an inch in breadth. The ventral sucker is of remarkable dimensions, and, in place of occupying the upper part of the body, as in ordinary flukes, is removed to the caudal extremity. The accompanying illustration, altered

from Blanchard, shows the character well (Fig. 4); and this lateral view of the parasite also permits us to recognise the oral sucker, *a*, the large digestive tube of the right side, *b*; affording likewise a good general outline of the water-vascular system, *c*, whose ultimate ramifications terminate in minute pouches.

The development of the amphistomes is exceedingly

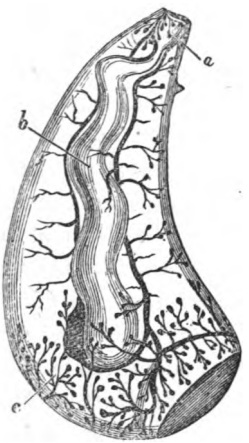

Fig. 4. The Common Amphistome.

interesting, not merely from a scientific point of view, but as throwing much light upon the general question of the origin and causation of fluke disease. A very closely-allied species of amphistome resides in the frog, and we have ascertained that its larvæ either take up their abode in, or dwell upon, the bodies of at least three different species of water snails. The larval trematode is well known to helminthologists under the title of *Cercarea diplocotylea*. It measures about the twelfth of an inch in length, and happens to be one of those cercarean forms which is furnished with eyes.

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To illustrate the leading characteristics of fluke development, nothing can be better than a few good figures of amphistomatous larvæ. Here are some carefully selected and much reduced in size, from Dr. Pagenstecher's admirable representations of trematode larvæ (Fig. 5). The larger larval form, A, represents what is termed a sporocyst, and through its transparent skin we may readily recognise the bulb of the œsophagus, *a*, leading to a globular and rudimentary stomach, marked *b*. In addition to the digestive organs, we may notice in the interior a variable number of loosely floating bodies, *c*; these

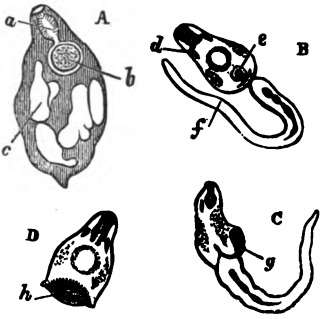

Fig. 5. Larval Amphistomes.

latter being internal buds, so to speak, destined to be transformed into perfect cercariæ.

The somewhat more highly organised larva or Cercarea, B, exhibits a pair of eyes, *d*, a ventral sucker, *e*, and a conspicuous tail, *f*; and when the same microscopic creature is viewed laterally, as at C, we observe an additional cavity, *g*. By the dislocation of the tail, which is eventually thrown off, as seen in the cercarean form marked D, this hollow space, *h*, imparts a truncate figure to the animalcule. A cercarea in this unhappy-looking, tailless

condition is termed a pupa, which is the highest sexually immature stage of fluke development. In this advanced condition it becomes encysted in the body of the water snail or intermediary bearer; being afterwards tranferred to its ultimate host, within whose intestinal canal it is at length transformed into the perfect amphistome. Very much more might be said on this subject, but I fear to complicate my record of the developmental phenomena exhibited by flukes. Whilst the larger features of this strange kind of metamorphosis are tolerably uniform throughout the trematode group, the lesser modifications of plan by which these creatures reproduce and multiply without intercourse are practically infinite. It is worthy of note, however, that external causes, such as excessive heat and moisture, lie at the root of the matter, so that the multiplication of flukes during particular seasons is readily accounted for.

Only by the precise enunciation of such facts as these can it be hoped that our agriculturists will be duly impressed with the practical importance of researches in helminthology. With these data before them, they cannot deliberately refuse to recognise the now well-established truth that cattle and other ruminating animals become infested with flukes—distomes, amphistomes, fascioles, and what not—in a direct manner when they drink from ponds, stagnant pools, and even running streams of water. It is probably not necessary that the pond snails themselves should be swallowed, seeing that the free-swimming cercariæ appear to be able to complete their fluke development without passing through the encysted pupal stage within the bodies of their intermediary bearers. In the case of the amphistomes it is almost certain that the free tailless cercariæ, when thus

transferred to the paunch of cattle, will assume their definitive adult form and characteristics within the space of a very few days, or even hours.

In respect to other practical bearings, apart from those already referred to in connection with the developmental history of the amphistomes, I would observe that, as these parasites are constantly overlooked, so also has the probability of their proving injurious to their bovine hosts escaped suspicion. Their general resemblance to the large pedunculated villi of the paunch, amongst which they lie concealed, readily accounts for the little attention hitherto paid to them; in fact, not one person in twenty would be likely to observe them, unless specially in search of entozoa. It is little to the point to say that it is of no use acquiring a knowledge of these amphistomes because veterinarians have never yet diagnosed their presence in the living animal; neither is it so obvious that they cannot give rise to disease, merely because no local pathological indications display themselves within the rumen. Depend upon it, when these paunch-infesting flukes occur in large numbers, the host is more or less inconvenienced, and if the bearer is not a strong beast constitutionally, external symptoms of impoverished health will sooner or later appear. In this way it is that some of the comparatively harmless entozoa become injurious to their bearers, whether bovine or human. Nay more, there may be no obvious external symptoms; and yet, as remarked in a paper on the grouse disease (The *Field*, Nov. 9, p. 451), there may be a gradual and insidious undermining of the health, such as I have frequently witnessed in human bearers who have come to me complaining of loss of appetite with general depression of the vital powers.

The late Mr. Youatt, when commenting on a remarkable case of death from canine parasitism (where poisoning had been suspected), very truthfully observed: "The history of the entozoa has been unpardonably neglected by veterinary practitioners." Since his time, however, the labours of Professors Simonds, Dick, Brown, and others, have thrown much light upon the pathological aspects of entozoal research; but all is not yet known that might be, in connection with these amphistomes. Not alone in cattle have these parasites been found. They occur also in the sheep, goat, red deer, roe, fallow, elk, and certain species of antelope. Moreover, two other amphistomes, alleged to be distinct, have been detected in the well-known Indian variety of the ox termed the zebu. One of these (*Amphistoma crumeniferum* is obtained from the paunch; the other *Amphistoma explanatum*) from the gall bladder and hepatic duct. Although in possession of specimens from the zebu, I have not yet been able to verify the published statements respecting the distinctive characters given in Creplin's original description of the worm from the paunch; but this is of little practical consequence.

In conclusion, I may mention that a number of carefully mounted amphistomes may be seen in the entozoological series of the Hunterian Museum, Lincoln's-inn. The examples were originally obtained by Mr. Clift from the paunch of a reindeer.

CHAPTER III.

TAPEWORMS OF CATTLE—CESTODE PARASITES EXHIBIT STRANGE GENETIC PHENOMENA—THE LONG TAPEWORM—DOES IT INCONVENIENCE THE BOVINE HOST?—PROVES FATAL TO LAMBS—TREATMENT RECOMMENDED—THE TOOTHED TAPEWORM—CESTODE LARVÆ ABOUND IN CATTLE—THE BEEF MEASLE—ITS PREVALENCE IN NORTHERN INDIA—EXPERIMENTAL RESEARCHES IN ENGLAND AND GERMANY—BY WHOM CONDUCTED—METHOD PURSUED—SCIENTIFIC RESULTS—THE SO-CALLED CESTODE TUBERCULOSIS—UNSCIENTIFIC PERSONS SHOULD NOT BE APPOINTED AS MEAT-INSPECTORS—TECHNICAL INFORMATION IS NECESSARY.

I NOW pass on to consider an entirely distinct group of parasites, few of which are found in the adult condition in the ox, although several species of the same order attack cattle as internal parasites whilst passing through their larval stages of growth. I allude to the *Cestoda*, or tapeworms: and in this relation I may observe, once for all, that a knowledge of the metamorphoses exhibited by these singular creatures during their development and wanderings is of the utmost importance, alike to the student of veterinary medicine, to the physician, and to the sanitarian or officer of public health. Furthermore, the naturalist (if he be capable of grasping the significance

of all the larger data supplied by the facts of development throughout the entire chain of organic beings) will not fail to account the genetic phenomena displayed by these tapeworms as amongst the most remarkable which have ever engaged the attention of the biological investigator.

Of all the tapeworms hitherto found by helminthologists, there is not one, I believe, which attains so great a length as the species which may emphatically be called the long tapeworm.

This species (*Tænia expansa*) commonly measures 30ft. or 40ft. from one end to the other, but several observers have recorded specimens as attaining 100ft. Some of the older writers confounded this parasite with the broad tapeworm of man, but the celebrated Pastor Goeze, of the Church of St. Blasius, in Quedlingburg, recognised its specific distinctness. As a species it is easily known, not merely by its size, but also from the circumstance that its individual or separate segments exhibit reproductive papillæ on either side at the centre of each lateral margin. In the accompanying illustration (Fig. 6),

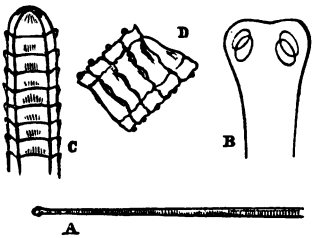

Fig. 6. Head and Segments of the Long Tapeworm.

altered from Goeze, the head and neck (A) are represented in their natural size, the outline at B showing an enlarged view of the head furnished with four bilaterally disposed suckers. The portion to the left marked C shows the tail

end of an immature specimen, having two conspicuous water vessels, which terminate together at the central point of the caudal segment; whilst the fragment D, which in this drawing is less then one-half of the actual breadth of the body of the worm, shows the narrow character of four of the mature segments, and more particularly, also, the situation of the bi-serially-arranged reproductive papillæ, one on either side of each joint or division.

That a worm upwards of twenty, or it might be thirty yards in length, should dwell inside any quadruped without creating inconvenience to the bearer is scarcely credible; nevertheless I am unacquainted with any records of symptoms clearly referable to this source in the ox. Probably the comparative rarity of the long tapeworm in cattle may partly account for this absence of evidence; but I rather suspect that the occurrence of the entozoon, and the symptoms occasioned by its presence have been frequently overlooked. At all events, the same parasite gives rise to disagreeable phenomena in the sheep, sometimes proving endemically fatal to young lambs. In 1855 hundreds of these animals perished from the ravages of this tapeworm, as proved by Mr. W. Cox, V.S., who described the symptoms as those of "loss of condition, loss of appetite, diarrhœa, or rather dysentery." No doubt cattle can resist the irritation thus set up better than such comparatively small and feeble ruminants as lambs; so that a genuine and fatal epidemic from this source is hardly likely to occur in oxen. However, if these tapeworms be observed in herds, even should there be at the same time no very marked symptoms, I would advise the administration of tæniafuges. In the case of full-grown cattle I would recommend the

administration of an ounce of powdered male fern, in combination with an equal quantity of pulverised areca nut. This should be followed by a brisk cathartic, and repeated at intervals of four hours if necessary. Treatment by assafœtida, turpentine, and linseed—such favourite remedies with veterinarians—is a coarser, but by no means ineffectual method.

As I shall have occasion to revert to this subject when discussing the parasites of sheep, I will only here further observe that we are still entirely in the dark as to the source and specific characters of the tapeworm larvæ of this particular species of cestode. The suggestions made by Mr. Cox on this head are altogether at variance with the more healthy deductions to be gathered from recent scientific experiences. The nature and value of these indications will appear in the sequel; but, before I pass to their consideration, it remains for me to offer a few words on another bovine cestoid parasite, which may be called the Toothed Tapeworm.

This entozoon (*Tœnia denticulata*) is a small species of its kind, measuring only from eight to sixteen inches in length; realising, however, a breadth of from one half to nearly an entire inch. The head is square-shaped, and, as in its congener above described, is possessed of neither hooks nor proboscis. The suckers are large and globular; a more distinctive characteristic being noticeable in the form of the joints or segments, which are twenty times broader than they are long. As in the other bovine tapeworm, the reproductive papillæ are double; one being placed on either side of each division or proglottis—as the joint is more correctly called. Nothing is known respecting the development of this species; and, so far as I am aware, it has never been

seen infesting any quadruped except the ox. Its name is derived from the serrated character of the lateral margins of the joints or segments.

Although the cestoid parasites are but feebly represented in the ox, considered as a bearer of tapeworms properly so called, nevertheless this remarkable type of entozoon finds no inconsiderable expression as a bovine guest in one or other of its juvenile stages of development. Thus, in plainer terms, it may be affirmed that the larvæ of tapeworms abound in cattle, whilst the cestodes in their adult condition are of comparatively less frequent occurrence. Issues of the highest practical importance are intimately associated with a correct understanding of this part of the science of helminthology, and it is therefore a happy circumstance to be able to state that our labours in this phase of the subject have been rewarded with the highest scientific successes. As the facts to be brought forward are numerous, intricate, and involved, I hasten without further prelude to introduce them by an account of the Beef Measle.

This parasite (*Cysticercus bovis*), though totally unknown to butchers and fleshers at home, is nevertheless familiar to those persons in India whose duty it is serve out rations to our troops stationed there. Of this fact we have lately received cumulative proof, more particularly through the sixth annual report of the Sanitary Commissioner with the Government of India, through the Bombay Health Officer's Report for the fourth quarter of 1870, and by the report of Assistant-Surgeon T. R. Lewis "on the bladder worms found in beef and pork," some account of which appeared in the *Lancet* for Dec. 14, 1872 (p. 860).

Still more recently the Inspector-General of the

Indian Medical Department has contributed to the February number of the *Madras Monthly Journal of Medical Science*, a series of papers on this subject; commencing with a "Report on the prevalence of Cysticercus in the ration beef at Jullundur, Punjab, with observations, as to the probable sources of infection, and the results of consumption of this meat as an article of food." In this connection, also, I have received a valuable record from the pen of Assistant-Surgeon Joseph Fleming, M.D., of the Army Medical Staff, who was long stationed in Northern India.

Dr. Fleming, recognising the practical value of our researches conducted at the Royal Veterinary College in England, was amongst the earliest, if not the very first, to discover the existence of beef measles in India. In the pages of the *Indian Medical Gazette*, for 1869, he drew attention to the subject, and pointed out to the authorities the methods of preventing this form of parasitism; basing his statements on our experimental results, on his own frequent inspection of cattle in slaughter-yards, and also on examinations of the local sanitary conditions of many cattle-rearing districts, especially in the Punjab. It is impossible to do full justice to Dr. Fleming's useful observations; but amongst other things, he remarks that about eight per cent of the European and Native Inhabitants of the Punjab are afflicted with tapeworm. As we shall see, this parasite is chiefly derived from eating beef.

The beef measle is a larval cestode, or in other words one of the sexually immature stages of development of a tapeworm which infest the human body (*Tænia mediocanellata*); this mature worm being, as I have repeatedly shown, far more frequent as a human guest than

the falsely so-called common tapeworm (*Tænia solium*) derived from eating pork.

In the "Proceedings" of the Royal and Linnean Societies I have given full details of certain experiments by means of which Professor Simonds and myself were enabled to demonstrate, beyond the possibility of a doubt, that the ox was just as liable as the pig to entertain tapeworm larvæ within the substance of its flesh. It is true that in this particular relation our experimental success had been anticipated by the results obtained from one or more experiments instituted by the eminent German helminthologist, Rudolf Leuckart; yet verifications were necessary, in order to insure for these results their definitive acceptance both at home and abroad. To speak of measly pork is one thing, but to suggest that the beef of old England could ever be similarly corrupted must require strong proof before such an insinuation could be complacently listened to. I have been amused alike at the scepticism and deplorable ignorance of the butchers whom I have asked if they had ever encountered such parasites.

If a calf, heifer, or full-grown ox be induced to swallow the ripe and living eggs of the human tapeworm in question, the contents of the ova thus ingested will in course of time become transformed into measles. Here, for example, is a representation of the hind quarters of a calf which was one of our experimental animals (Fig. 7). The skin has been removed, in order to expose the muscles of the haunch; these, with one exception, being shown in outline only, as at *a*, *b*, *c*, *d*, *e*. The large central muscle, known as the *vastus externus*, gives a good general view of the arrangement of the measles at the surface. Of course, in nature, few cattle would be liable

to infest themselves to the extent here artificially induced; consequently they are usually spared the inconveniences resulting from the wanderings of any very considerable number of these larvæ in their interior. Swine, whose habits are less cleanly, do not enjoy the same immunity, for in them the measly condition may assume proportions almost equal to anything of the same kind which we have

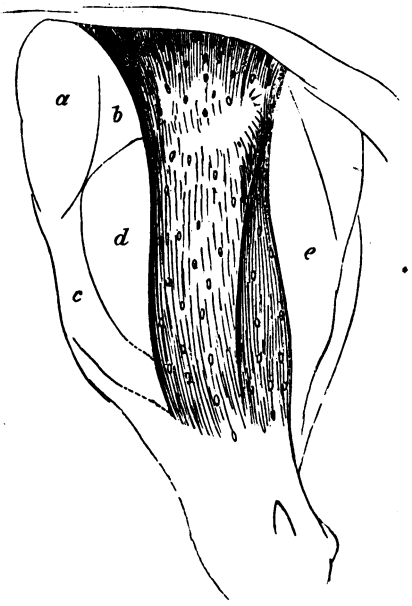

Fig. 7. Hind Quarters of a Calf showing Measles.

experimentally produced in cattle. On the other hand, swine will undergo a large amount of parasitism without displaying those external evidences of suffering which other animals are apt to betray under similar circumstances. Thus we see how it happens that measly beef

is not so likely to attract the attention of the flesher as measly pork, since the measles of the most infected cattle are but "few in number and far between." In pathological language we term the measle disorder "*cestode tuberculosis*," and we do so with equal propriety whether the disease manifests itself in the ox, in the pig, in the sheep, or in any other animal.

The recognition of the different forms of measle should be made a matter of conscientious study by veterinary practitioners; for, even if not themselves called upon to act as inspectors of meat, circumstances may arise under which their opinion may be demanded. Such appointments, indeed, ought to be held by accomplished veterinarians, instead of being relegated to the police, four of whom, we are told, act in one of our cities "as animal food inspectors, under the direction of the deputy clerk of the markets." Could anything be more preposterous?

In further proof of the importance of giving these posts to properly qualified and educated persons, I may mention that I have in one case been asked to supply privately the necessary information touching these measles to an inspector of slaughterhouses connected with one of the largest towns of England.

By the aid of a microscope, or with the assistance of a powerfully magnifying pocket lens, the distinctive characters of the various meat measles may be readily made out. Indeed, the naked eye alone is in most cases sufficient to determine the nature of spots and specks in meat, if the inspector has been properly educated in the art of discriminating them. On this subject my opinion is continually solicited by interested persons.

When fully developed, the capsuled beef measle does

not usually measure more than one-fourth of an inch in diameter; consequently, it is much smaller than the corresponding cysticercus of the pig.

I am indebted to Dr. Fleming for a remarkably fine and beautifully mounted beef measle removed from its capsule. The specimen was obtained at Mean Meer on the 30th of August, 1869. In the unrolled condition the measle measures 5-8ths of an inch from head to tail; the caudal vesicle being 3-8ths of an inch in breadth. The base of the so-called neck gives as much as $\frac{1}{8}''$ in diameter.

As will be seen in the sequel, there are other diagnostic marks of greater value.

CHAPTER IV.

BEEF AND PORK MEASLES CONTRASTED—ESSENTIAL MARKS OF THE BOVINE CYSTICERCUS—CHARACTER AND FUNCTIONS OF THE CENTRAL SUCKING ORGAN OF THE HEAD—ENGLISH MEAT INSPECTORS UNACQUAINTED WITH THE BEEF MEASLE—MEASLY BEEF SOLD IN THE BOMBAY MARKETS—EXTRAORDINARY PREVALENCE OF CYSTICERCI IN THE FLESH OF CATTLE IN THE PUNJAB—EXPLANATION OF THIS PHENOMENON—ITS BEARING ON THE SEWAGE QUESTION—INTERESTING STATEMENTS BY DR. JOSEPH FLEMING—DISGUSTING HABITS OF NATIVE CATTLE AND SWINE—A QUESTION OF DIAGNOSIS.

If a strict comparison be instituted between the measles of beef and pork, it will be found that they differ from one another not only in respect of the relative size of their bodies, but also as regards the form and armature of the head. It is particularly noteworthy that these marked divergencies of shape and structure are equally well pronounced in the adult or final stages of development. It cannot be said, however, that a similar degree of distinctiveness holds good in the case of the mutton measle, which, as I shall hereafter show, resembles very closely the cysticercus derived from pork.

At the risk of anticipating some few facts that I must needs make more clear by-and-by, it is, in the meantime,

practically important to illustrate the separate peculiarities of the measles side by side. Here, therefore, I have given an enlarged view of one beef measle within its cyst, accompanied by magnified representations of the head of the beef and pork tapeworms respectively. The measle shows a stout, laminated, fibrous envelope, which consists of layers of connective tissue, the latter belonging to the flesh of the host; whilst, in the interior of the capsule, the head and neck of the cysticercus are readily seen through the transparent, bladder-like caudal vesicle. The head is apparently inclosed within the bladder, but

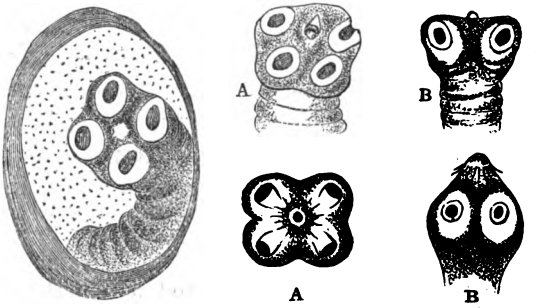

Fig. 8. Measle and Tapeworm Heads.

it is in reality outside the vesicle, a portion of which has become depressed to admit the head, after the fashion of an inverted finger of a glove. We term this involution the "receptaculum capitis." The caudal vesicle is very thin, but it displays minute specks, which are due to the presence of calcareous corpuscles; these bodies being much more abundant in the substance of the head and neck. The head exhibits four large suckers, equidistantly arranged in pairs at the angles of the square-shaped head; and under favourable circumstances we may

always detect the presence of a central depression, which some helminthologists are disposed to regard as a fifth or supplementary sucker. The opaque character of the head and neck is due to the excessive multiplication of the calcareous particles, combined with a greater density of the substance of the parasite in these parts. If these characters be compared with those shown by the two uppermost tapeworm heads, as given in the drawing, a glance is sufficient to determine their correspondency. The upper figure at A, showing the head as viewed diagonally, demonstrates that the four large suckers precisely resemble those of the beef measle; whilst the characteristic supplementary depression is somewhat more conspicuously developed. I have satisfied myself that this falsely so-called sucker does not strictly belong to the category of cup-shaped holdfasts—at least, not in the same sense as the ordinary suckers do—but it corresponds, both structurally and morphologically, to the head processes of such tapeworms as are furnished with retractile proboscides. It is in the tapeworms of birds especially that these appendages attain the most striking degree of development; their principal function being to furnish a powerful means of anchorage. The presence of these organs often imparts a grotesque appearance to the head of the tapeworm, as may be seen, for example in the case of the *Tænia paradoxa*, from the oyster-catcher. I have figured a specimen of this worm in my general treatise (p. 108). But, reverting to the illustrations, the profile view of the head of the beef tapeworm (fig. 8, B above) shows this spurious sucker projecting beyond the middle line at the centre. I may mention that, during my examinations of the fresh parasite, I have repeatedly caused this organ

both to project and retreat at my pleasure. I have, therefore, not the smallest doubt but that during life the process in question is perfectly capable of being thrust forward and backward at the will of the entozoon, as undoubtedly obtains to a more striking degree in the case of those tapeworms which are armed with a retractile proboscis or *rostellum*.

I have purposely dwelt upon the character and functions of the central organ because several able and estimable observers appear to have entirely misunderstood the nature of this structure. In the pages of *Nature*, indeed, I have already animadverted upon this prevalent error; but hitherto I have been unable to give adequate expression to the opinion, which is here offered only after a careful and prolonged investigation of the question at issue. In this relation, also, I have yet further to remark that the head of the pork tapeworm (as shown in the two lower representations) not only presents a quadrilobate figure when seen from above, as at A, but that it also exhibits a distinctly conical figure when viewed in profile, as seen at B. Moreover, the upper part of the rostellum displays a double circle or coronet of hooks, the points of which are seen to project conspicuously at the circumferential margin of the crown.

A full and satisfactory view of the beef measle can only be obtained by rupturing the cyst, and then, by subsequent gentle pressure, causing the head and neck to protrude from the receptacle. It will now be seen that the so-called neck, which some entozoologists with equal propriety term the body, presents a series of transverse folds which are correctly regarded as the limitation lines of a set of imperfectly developed segments. These, in the adult tapeworm, eventually become

the earliest transformed sexually mature proglottides. Notwithstanding the many figures that have from time to time appeared, there is probably no representation of the beef measle so excellent in all respects as the enlarged one given in Dr. Hewlett's instructive report already alluded to (p. 23). The original drawing was made by Dr. Temperley Grey, and the accompanying woodcut is a reduced copy of his figure.

The measle is here magnified to nine diameters. By

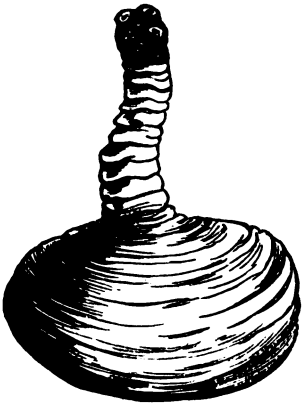

Fig. 9. Ox Measle, or Bladder Worm of Beef.

this figure it will especially be noticed that the transverse *rugæ* of the neck are continued below, so as to present a series of more or less uniform circular folds extending in parallel lines over the whole surface of the bladder-like caudal vesicle.

Some persons may think that I have been unnecessarily minute in the foregoing description of the beef measle; yet they will judge otherwise when I state that no instance has yet been placed on record of its

having been detected by meat inspectors in England. Abroad it is otherwise; though in Germany, where the adult parasites are quite as abundant as they are with ourselves, they have only once or twice been seen in meat about to be sold as food. Neither in France, Holland, Denmark, nor Russia, do they appear to have been encountered by inspectors; and yet, in one and all of these countries, the parasites in question undoubtedly occur in beef and veal more or less copiously. "According to our experience," writes Dr. Hewlett, "the buttocks of the cattle are usually more infested than the rest of the body, so that persons who are fond of rump steaks should be more than usually cautious." Dr. Hewlett ackowledges his indebtedness to the practical findings of Dr. Veale, who, "on more than one occasion," brought to him portions of meat containing cysticerci; such pieces having actually been sold as food in the Bombay markets.

None of our Indian professional investigators appear to have discovered measles in mutton; and it is probably not known to them that I have observed them in joints brought to table. The importance of this interesting fact will appear more significant when we shall have finally determined, by our experiments, the true form and character of the tapeworm constituting the adult representative of the mutton measle.

The experiences of Dr. Joseph Fleming are so remarkable and interesting, in connection with the prevalence of measles and other forms of parasites in the Punjab, that I am constrained to lay particular stress upon them. He writes me word to the effect, that during his seven years' service in India, he scarcely ever inspected the body of a slaughtered ox or cow,

without finding either hydatids in the lungs or liver, or cysticerci in the muscles. He adds :—"It was frequently a matter of surprise to me that the functions of the lungs and liver could be carried on, so infested were these organs with hydatids and flukes which often produced profuse suppuration. "Contrary to the recorded experiences of some other observers, Dr. Fleming states that he never noticed that the mere age of the animals exerted any influence in regulating the numbers of cysticerci found in the muscles of Indian cattle.

In connection with the subsidiary question, as to the degree of infection which animals may acquire by natural causes, my informant's subsequent remarks are highly important; and, from what follows, any intelligent person, not voluntarily blinded by prejudice, must perceive that Dr. Fleming's statements have an important bearing on questions of public health, more particularly in relation to the possibilities of infection arising from the distribution of sewage, or water containing fresh fæcal matter. On this latter point he writes to me in the following terms :—"I have been an eye witness to the disgusting spectacle of cattle eating greedily the fresh human evacuations in the neighbourhood of Indian Villages, and have been told that sheep do the same thing. It is a daily occurrence in India, when pigs are plentiful, to see these animals watching the natives, in the morning especially, and devouring the excrement as fast as it is deposited. I believe the natives sometimes carry stout sticks to beat the pigs off."

"I look upon the dirty pools which are placed within a few yards of most Indian villages, as the principal medium through which cattle become cyst-infected. The customs of the natives, the low level of these pools,

the periodic rainfall, and other circumstances, tend to localize the parasitic ova in certain places, and thus it is impossible for the cattle to avoid swallowing the eggs while seeking to allay their intense thirst."

Such are the facts recorded by an able and accurate observer; and Indian officers, who have placed themselves under my professional care as sufferers from tapeworm, have verbally confirmed the truth of Dr. Fleming's statements in respect of many of these particulars. My friend, Colonel Gibb, formerly of the Royal Artillery, assures me that he has repeatedly witnessed the same phenomena.

Incidentally, Dr. Fleming also alludes to the presence of cysticerci at the root of the tongue of oxen. On this point he says:—"The largest beef measle I ever saw was obtained from the side of the tongue, and when unrolled in length was about one inch and a half." Thus also, the Inspector General, in the Madras Journal's Report alluded to, speaks of Major Biggs, the commissariat officer in the Punjab, as having seen an animal at Rawul Pindee, "in which immense clusters of these cysts could be felt at the root of the tongue."

Some have sought to point to these facts as a useful means of diagnosing the existence of measles, or rather of the disease called cestode tuberculosis, in the living animal; but this suggestion is practically of no value, since, as the Inspector-General himself has remarked, their occurrence in this part of the body only takes place in "exceptionally severe instances" of the disorder.

CHAPTER V.

PROPOSITIONS RESPECTING THE CAUSATION OF MEASLES IN CATTLE—INDEBTEDNESS OF PROFESSIONAL MEN AND SANITARIANS TO EXPERIMENTAL HELMINTHOLOGY—ADMINISTRATION OF MEASLES TO THE HUMAN SUBJECT BY DR. OLIVER—CESTODES HAVE DIFFERENT PERIODS OF MATURATION—THE TAPEWORM IS A CHAIN OF ZOOIDS ARRANGED IN SINGLE FILE—DESCRIPTION OF THE BEEF TAPEWORM—DISPERSION OF EGGS—FURTHER PROOFS OF THE ABUNDANCE OF BLADDER WORMS IN THE CATTLE OF NORTH-WESTERN INDIA—THEIR COMPARATIVE RARITY IN CALCUTTA—MEASLES FOUND BY DR. LEWIS IN A COLD SIRLOIN OF BEEF—IGNORANCE OF ENGLISH BUTCHERS AND FLESHERS—THE WELFARE OF MANKIND IS INTIMATELY CONNECTED WITH THE HEALTH OF CATTLE—VALUE OF HYGIENIC MEASURES SHOWN BY THE INDIAN SANITARY COMMISSIONER'S SEVENTH ANNUAL REPORT—WHY PARASITISM IS LESS PREVALENT IN ENGLAND THAN IT IS IN INDIA.

FROM the facts set forth in the previous chapter, it becomes perfectly obvious that the prevalence or the rarity of measles in cattle in any given country must be determined primarily by the habits of the people; for, since the beef or veal measle can only result from the ingestion by the ox or calf of the eggs of the human

tapeworm known as the *Tænia mediocanellata*, it is clear that the degree of infection of these animals will correspond with the facilities offered for egg-dispersion. In like manner it may also be affirmed that the frequency of this particular species of tapeworm amongst the people occupying any given area will bear a strict relation to the amount of underdone measly beef and veal consumed by the inhabitants.

These two propositions form the counterpart of each other; and unless we happen to possess an almost unlimited belief in the doctrine of heterogenesis, or spontaneous generation, there is no escape from the well-established truth hereby enunciated. In short, only those persons whose minds are still embarrassed by preconceived opinions, based on conclusions handed down by the ignorant, can have any difficulty in accepting so obvious a general statement of results. It is quite possible that further researches may show that other bearers than calves and oxen may be capable of harbouring the beef measle. Yet, even should this turn out to be the case, the force and truth of the proposition in question would not be disturbed in the slightest degree. If it should further be shown that in some countries where this characteristic tapeworm abounds, the beef measle is either little or altogether unknown—as happens, for example, in Abyssinia—then the reply to these doubters is to the effect that the larval tapeworm has seldom or never been sought for; and manifestly so, because the relations subsisting between the two forms of one and the same parasite have hitherto failed to attract the attention of the parties concerned.

Whilst with satisfaction I recognise the increased interest taken in this subject by our professional

brethren in India, I regret to notice how slow they have hitherto been to acknowledge their indebtedness to experimental helminthology. But for our laborious and successful efforts in this department of scientific work at home, they could not have known of the intermutual relations of the measle and tapeworm of beef. No doubt they might have guessed as much from the experiments successfully initiated by Küchenmeister on condemned criminals with the pork measle; but, as regards the beef tapeworm, even Leuckart himself doubted, in the first instance, that which his own experiments and my verifications subsequently proved to be true.

Many other experiments are necessary to complete our knowledge of the genesis of the different species of cestode parasites; and we shall continue to make them from time to time, although our labours may not happen to receive their due recognition at the hands of those we have principally benefited. The exhilarating effect produced on the mind of the investigator by the sudden in-rush of a newly-aquired scientific truth is in itself a reward quite apart from the larger consideration of contributing to the welfare of mankind.

If I offer these remarks in a tone of gentle reproach, it is in order that I may do the more justice to diligent co-workers in India, who, profiting by our researches, have not only contributed a series of valuable facts as the result of mere observation, but have likewise recently entered upon the more difficult and instructive path of experimental inquiry.

In this connection I allude more especially to the experiments conducted by Dr. Oliver, of the Royal Artillery, stationed at Jullunder. By the courageous

administration of beef measles to a low-class Mahommedan syce, and also to a Hindoo boy, he succeeded in artificially rearing the *Tænia mediocanellata*. These human bearers were, it seems, perfectly willing to play the part of host to a class of guests which most of us contemplate with aversion. The interest of this experiment, however, lies less with the circumstances attending its conduction, than with the practical issues associated with its success. In particular, we have here afforded us incontestable proof that the beef tapeworm requires a period of twelve weeks for its perfection, as such; and thus also is confirmed a truth that I had long previously maintained and enforced on other than experimental grounds. From professional data alone I have repeatedly been enabled to predict how long it would take tapeworms to re-form in human bearers after their more or less incomplete evacuation as the result of treatment. Different tapeworms severally require unequal periods for their full maturation; but at present we are only acquainted with the amount of time consumed in the case of those forms which have been made the subject of experiment. It would be very interesting to learn how many months are requisite to complete the development of the long tapeworm of the ox and sheep; the more so, since it only requires six weeks for the perfect development of the hydatid-forming tapeworm of the dog (*Tænia echinococcus*). These practical points merit further consideration.

It is not very easy to convey to any person unfamiliar with parasites an accurate idea of the singular appearance presented by an ordinary beef tapeworm when removed entire from the host and spread out at full length. Philosophically speaking, we have in such an entozoon a chain

of zooids, or individualised creatures, linked together in single file. In short, they form a true colony of incomplete individuals; all of them budding from the head, and extending in one direction. This accounts for their singular tape-like shape: and, in order to afford some notion of this peculiar character, I have here caused an ordinary beef tapeworm to be drawn, reduced to exactly one-sixth of its natural size (Fig. 10). This is an accurate

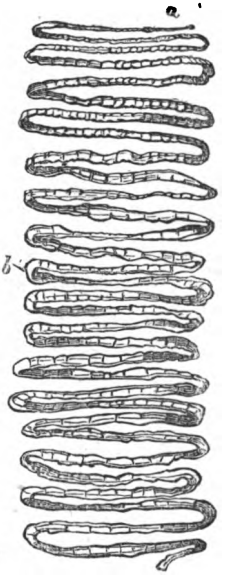

FIG. 10. BEEF TAPEWORM (REDUCED TO ONE-SIXTH).

representation of a specimen measuring thirteen feet in length. It is taken from a photograph sent to me by Dr. Fock, of Utrecht, who is the author of a popular pamphlet on tapeworms ("*De lintworm en het middel om hem uit te drijven*"). Such a specimen as the one here figured numbers about 1200 joints or segments,

each of these being capable of developing in its interior some 30,000 eggs; consequently, if all the joints of such a worm should arrive at perfection, they would collectively afford a total of more than thirty millions of ova. It is not usual, however, to find at one time more than seventy or eighty of the joints full of perfectly ripe eggs. On the other hand, it must be borne in mind that, as during life the ripe segments are cast off at the rate of about 400 per month, any one person who is playing the part of host to this worm is liable to be the means of dispersing abroad upwards of one hundred millions of these eggs annually. Of course only a very small number of the ova thus distributed ever arrive at their destination within the bodies of cattle; nevertheless, as we have seen, a sufficient number of them gain access to the intermediary bearers to ensure for the species an extensive propagation. Fortunately, as one substantial result of scientific research, we know how to put a limit upon the amount of egg-dispersion, and thus check a nuisance which, without proper precautions, might become well-nigh intolerable.

The subject of egg dispersion in connection with the propagation of parasites in general, and of tapeworms in particular, is too large to be discussed here to the extent which it deserves, especially if we should consider the facts in relation to the sewage question. In its bearings on the public health, this phase of the subject has already been treated of in the pages of the *Field* for March 18, 1865. I must, however, further enlarge upon this topic in connection with the production of the bladder-worm disease of cattle. If at home it be the fashion in certain quarters to ignore the facts of the case, it must, at all events, be allowed that the attitude of our Indian

sanitary authorities is at once both intelligent and energetic. To Dr. James Cunningham, the Sanitary Commissioner with the Government of India, I am indebted for the eighth annual report recently issued at Calcutta. The facts therein set forth confirm my previous statements elsewhere made as to the prevalence of measles in the north-west provinces of Hindoostan. The abundance of bladder worms in ration beef has been demonstrated by the fact that "during 1869, out of 13,818 head of cattle slaughtered in the stations of the Upper Punjaub, 768 beasts were found to be infected with cysts." This affords a ratio of 5·55 per cent., being a considerable diminution of the proportion observed in 1868, when the per-centage gave a total of 6·12. Doubtless the proportion suffered a still further diminution in 1870, owing to the vigilance and enlightenment of the Army meat inspectors.

If the entire facts of the case are duly weighed, it is not easy to account for so large an amount of "measling" on the ground of mere egg dispersion as such; but the difficulty vanishes when we consider that the habits of the natives and others render it possible for an ox or calf at any given time, when grazing, to ingest one or more perfect segments, or tapeworm proglottides, along with their fodder. Only by such wholesale modes of conveyance of the ova can we account for the abundance of measles detected in certain slices of meat.

One might be disposed to think that the amount of measling which Professor Simonds and myself induced in two animals by artificial means must necessarily be far in excess of anything which has been seen in the Punjab; nevertheless, such is far from being the case. It should be borne in mind that the presence of a score

of bladder worms in a pound of beef would afford a total of many thousands of measles in an ordinary full-grown ox. That such an amount of infection may actually occur in nature appears evident from the circumstance that the small slice of meat here figured was obtained at Calcutta, where cyst-affected meat is admitted to be rare.

In proof of this comparative immunity, at Calcutta, I may adduce Dr. Lewis's testimony, which is particularly interesting as well as instructive. Speaking of the measles, he says: "After trying in vain for months to obtain a sample, I felt greatly surprised

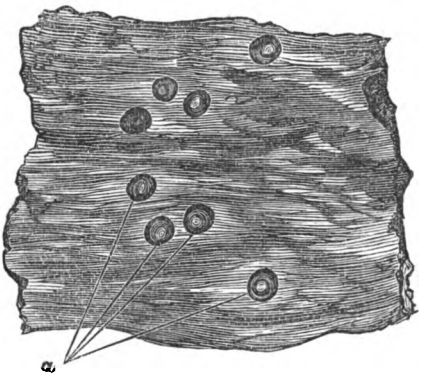

FIG. 11. SLICE OF ROASTED MEASLY BEEF.

at having after all to make their acquaintance, for the first time here, in a cold sirloin placed before me at breakfast, and off which I had dined on the previous evening without the slightest suspicion. The beef, it seems, had been obtained at the Dhurumtollah bazaar in the usual way." The accompanying illustration (Fig. 11) represents a portion of Dr. Lewis's cold sirloin, in which, to use his own words, the bladder-worm

cysts exhibit "a highly characteristic appearance." The slice itself has been cut and unfolded so as to show four measles (*a*), which, lying pretty nearly on the same level, have been severally divided by the knife into more or less equal moieties.

Some of my specimens of measly veal and beef show twice or thrice as many cysts within a similar area; but I have purposely preferred Dr. Lewis's representation, as giving a fair and in nowise exaggerated view of the natural possibilities of the case under ordinary circumstances. To the butcher who supplied the sirloin Dr. Lewis dispatched a messenger, hoping to obtain some more choice specimens of the meat for the purposes of experiment, but he was disappointed by the reply that the beef in question was "all sold."

Striking as is the evidence thus adduced by Dr. Lewis and others respecting the prevalence of measles in India, I have seen no statements which are so remarkable as those communicated to me by Dr. Joseph Fleming, of the Army Medical Staff. None of our experimental animals, though fed with scores of ripe proglottides, yielded such an abundance of cysticerci as he appears to have encountered in the Punjab cattle. In reply to my inquiries, he has deliberately stated, and I doubt not with perfect truth, that "in one pound weight of the psoas muscles he counted 300 living cysticerci." Clearly, facts of this order are of the highest practical value.

The degree of infection of measly meat can rarely be ascertained by applications to fleshers, since they have many motives for concealing their knowledge. Thus, at home, I have at times found difficulty in procuring samples of measly pork, although this form of parasitism is well known to butchers; and similar difficulties will

probably by-and-by occur in the case of measly veal and beef. At present measly beef is entirely unknown to our butchers, although for many years past I have exhibited specimens at public meetings of the British Association and on other occasions. In Calcutta the same obstacles to investigation exist, for Dr. Lewis has told us that "personal applications to the various Chinese pork butchers were found to be quite useless." However, he was enabled to procure abundance of specimens of the pork measles from the slaughterhouses located in the north-western suburbs of Calcutta; whilst, for the Punjab examples of cyst-affected beef, he was indebted to Assistant-Surgeons W. H. Jameson and G. Andrew, who forwarded them from Rawul Pindee and Fort Attock.

To any unprejudiced person it must now be perfectly evident that our own welfare is intimately bound up with the health of cattle. If they are largely infested with bladder worms, we become the more liable to infect ourselves with tapeworms. The most cogent evidence we possess respecting the value of precautionary measures is to be found in the Indian Sanitary Commissioner's seventh annual report. In the Punjab, the cattle which drank water contaminated by fæcal matter became largely infested; whereas those animals which were supplied with clean water, to which "human filth" had not gained access, were entirely free from the bladder-worm disease. To use Dr. Oliver's own words, "the cysticercus entirely disappeared from amongst the cattle a few months after means had been taken to secure them a good supply of well water." At Jullundur, where the cattle had been supplied with dirty tank water, it was clear that the disease originated with the camel drivers, "who are notoriously dirty in their habits,

and who are not unfrequently infested with *Tænia mediocanellata*. The most striking evidence, however, testifying to an astonishing amount of tapeworm egg-dispersion in the Punjab, is that which I have adduced from Dr. Fleming's experiences, and the truth of his statements has received ample verification from many independent sources. Scarcely less cogent, moreover, is the evidence supplied by Dr. Oliver, who, also speaking of the Punjab, remarks that "human filth was often to be seen on the banks of the tank, and the microscopic examination of mud and stagnant water, taken from the margin, exhibited tapeworm ova." This is the sort of practical evidence which is fortunately wanting in England, because the habits of our peasantry are more in harmony with civilised life.

Millions upon millions of the eggs of entozoa must gain access to the Indian tanks; and thus it happens that, while some parasites' eggs are taken up by cattle along with their green fodder, others are ingested with their drink, others again being actually swallowed with fæcal matter, eaten as food. It matters little how the eggs are swallowed. When once they are transferred to the true stomach, the shells will after a brief space be dissolved; the contained six-hooked embryos will soon make their escape; and, finally, by boring their way through the tissues, they will ultimately find a temporary resting-place within the muscles of the calf, heifer, or ox, as the case may be. Here, by metamorphosis, they will complete the course of their larval development within the flesh of the intermediary bearer; for in this situation it is that they await their subsequent passive and ultimate transference to the human alimentary canal.

CHAPTER VI.

THE SEWAGE QUESTION REFERRED TO—PREVALENCE OF TAPEWORMS AMONGST THE BURATES EXPLAINED—MEASLES IN THE HEART—TENDENCY OF CYSTICERCI TO PERISH BY CALCAREOUS DEGENERATION—PRACTICAL VALUE OF A KNOWLEDGE OF THIS FACT—DEGREE OF TEMPERATURE NECESSARY FOR THE DESTRUCTION OF BLADDER-WORMS IN FLESH—STATEMENTS OF DR. LEWIS AS TO WHAT CONSTITUTES WELL DONE MEAT—FOUR KINDS OF TAPEWORM LARVA ARE FOUND IN CATTLE—THE COMMON HYDATID—REMARKABLE SPECIMENS COLLECTED BY JOHN HUNTER—PREVALENCE OF ECHINOCOCCI IN INDIAN CATTLE READILY ACCOUNTED FOR—THE SLENDER-NECKED BLADDER-WORM—THE MANY-HEADED HYDATID—CASES OF "GID" IN THE OX—EMPLOYMENT OF THE TREPHINE—RECORDS OF STURDY IN ENGLISH CATTLE UNDULY SCANTY.

WHEN the sewage question was being discussed with a vigour and warmth of tone almost amounting to asperity, I was much taken to task by the *Lancet*, for not producing "a single specimen of beef or mutton containing measles which had not resulted from experiment;" but now, with the evidences adduced, I trust the editor of that ably conducted professional serial

will candidly admit that in this important matter I have hitherto advanced no proposition which cannot be substantiated by known and easily recognisable data. In its own pages for Feb. 25, 1865, my experimental successes were first announced; whilst experiences similar to those there recorded have since received abundant confirmation.

As I cannot enter into further particulars respecting the sewage aspects of this subject, I must refer those who are interested in them to the last of my Cantor Lectures, delivered before the Society of Arts, May 15, 1871. This Lecture was expressly devoted to "the general question of the parasitism of ruminants in relation to sewage and public health;" and in it I have endeavoured to refute all the more important arguments adduced by my opponents.

The astonishing facts brought forward by Dr. Kaschin, a medical officer attached to the Russian army, are too significant to be allowed to pass unnoticed. From him, through Leuckart, we long ago learnt that the Burates, or Cossacks, of the Baikal region are nearly all infested with tapeworms. They feed upon the flesh of calves, sheep, camels, and horses. They neither dress the meat properly, nor cook it completely. Fat, liver and kidneys are eaten quite raw; diseased animals being as much relished as half-rotten carcases. These people are, moreover, extremely voracious; any two of them being capable of demolishing a one-year-lamb at a single meal.

With such data before us, no one need wonder at the further assurances of Dr. Kaschin to the effect that in a hospital containing five hundred persons, who were being treated for other diseases, there was not a single patient who was not, at one and the same time, infested with

tapeworm. Fortunately these people suffer less than we ourselves would do were we placed in like circumstances and played the part of "host" to the same extent; but this consideration in no wise lessens the value of the entozoological evidences thus afforded. It may be added also that, as the Burates seldom eat pork, it is nearly certain that most of their cestode guests belong to the species of tapeworm which is derived from eating veal and beef.

The measles or cysticerci have a preference for the external muscles of animals, selecting principally those of the shoulder and haunch. They are comparatively rare in the deep-seated muscles, although I have found many of them in the diaphragm. An exception must also be made in favour of certain other muscles which help to form the walls of the abdominal cavity. Beef measles develop pretty freely in the loose cellular and fatty tissues; at least I have removed many from such situations. However, in contradiction to my personal experiences, Dr. Alexander Neill, in the Madras Report already quoted (p. 107), states that "the larvæ of *Tænia mediocanellata* will only come to maturity in the mucous membrane, [and] not in the cellular tissue of horned cattle." This assertion is not borne out by the facts noticed in my experimental calf, in which animal the connective tissues were invaded, especially in the regions of the so-called *facia lumbaris* as well as in that of the *linea semicircularis*. Measles are also liable to take up their residence in the heart; but, probably on account of the density of the muscular substance of that organ, they do not acquire so large a size as elsewhere, and, according to my own examinations, very few of them become perfectly formed. As seen in the specimen

here drawn from a figure by Mosler, but much reduced, the measles do not in such cases merely occupy the surface of the organ, but extend throughout the entire thickness of the muscular walls (Fig. 12). Many of them never so much as develop a head, and of those which do acquire this organ only a small proportion display the four large suckers characteristic of the perfect *Cysticercus bovis*. In certain examples I found

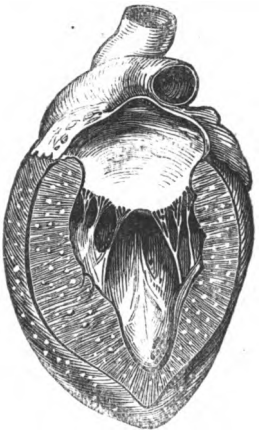

Fig. 12. Heart of a Calf with Measles.

only one, two, or three suckers developed, and in these instances the suckers themselves were either imperfectly formed, or showed indications of commencing degeneration at a comparatively early period.

This circumstance of the liability of measles to perish; and subsequently to degenerate into minute calcareous particles, is most important, practically; and I am happy to perceive that my early statements on this score have not escaped the attention of the officer

attached to the Indian Sanitary Commissioner on special duty. In a paper communicated to the Linnæan Society, and published in their Proceedings for July 1865, I furnished proofs as to the certainty of a natural cure of the measle-disease within much less than a year. I fixed the period at about eight months; but it now seems to me by no means improbable that the cure by degeneration may be effected at an earlier date. Be that as it may, it is most interesting to know that a measly ox or calf, however much diseased, is capable of soon outliving its contained enemies—that is, if the animal be removed from the original sources of infection. I believe six months to be ordinarily sufficient to effect this cure. This lapse of time will at all events ensure the death of the *cysticerci*, and thus prevent their proving injurious to any person who may chance to have swallowed them along with meat.

The next and final question for our consideration is that relating to the amount of cooking necessary for the destruction of these parasites. Some time past I remarked that when people persist in partaking of meat which has not been raised throughout to a temperature of 140° Fahr., they thereby render themselves liable to play the part of host. Prolonged cooking, whether by boiling or roasting up to this comparatively low degree of heat, is amply sufficient to destroy the measles of beef, pork, and mutton. Dr. Lewis more than confirms my testimony, and he adds many particulars of great interest. It is a mistake to suppose that all underdone meat is dangerous to eat; for, unless very raw, the temperature will probably have risen far above the protective limit. Dr. Lewis ascertained that the centre of legs of mutton put into the boiler reached

a temperature of 140° as soon as the water itself had risen to boiling point (212°), and in five minutes more the inner temperature of the joint rose to 170°. Chops and steaks, he says, "before being considered well done, should be exposed to a temperature of from 170° to 180°. At 150° they are considerably underdone; the red colouring matter has not disappeared, nor does it disappear until the meat has been subjected to about 10° more heat." No meat, it is thus argued, can be considered done unless all parts of it have been raised by cooking to a temperature of 150°. It thus becomes evident that the simplest precautions are amply sufficient to ensure for ourselves perfect immunity in respect of any of the tapeworms which are liable to gain access to the human frame, since even a very moderate amount of cooking kills these larval cestodes. According to Dr. Lewis, a temperature of 130°, if prolonged for five minutes, is sufficient to prove destructive; but, in order to insure absolute extinction of life in these parasites, he recommends that the meat be raised from 135° to 140°.

Seeing how constantly this degree of heat is actually attained under the ordinary modes of cooking employed in all civilised countries, it is really quite surprising how it comes to pass that so many Europeans manage to infect themselves with tapeworms. One can only suppose that very many persons prefer their meat almost raw. I have not found in practice many patients willing to allow that such is their habit. Naturally they would not like, in this matter, to be bracketed with semi-barbarous Burates and Abyssinians. Several persons, however, have excused themselves on the ground that their doctors ordered them to eat raw meat, as being more readily

digestible. On the other hand, a few honestly stated that they really preferred their meat "just warmed through," which was almost tantamount to saying that they ate it absolutely raw.

Obviously, this uncivilised attitude of the human bearer is precisely that which forms one of the principal factors concerned in, and therefore the most conducive to, the welfare and propagation of the tapeworms.

Having due regard to practical issues, quite apart from those already set forth in connection with my account of the beef measle, it will be advisable to return to the subject of diseased meat again; and I may add that the somewhat unpalatable statements, which in the interests of truth it will yet be my duty to make in this matter, will acquire all the more cogency if they are associated with my description of the parasitic diseases of sheep. Meanwhile, the facts relating to certain other bovine entozoa must necessarily engage our attention.

In addition to the beef measle, three other forms of tapeworm larvæ are liable to take up their residence within the flesh of the ox. All of them are likewise guests of the sheep, in which last-named host they are destined to play a more conspicuous part in the production of disease. In so far as they may be considered as bovine entozoa, I shall reduce my present notice of them to the briefest possible limits.

It is the custom with veterinarians to speak of all the larger kinds of bladder worms as hydatids. This want of discrimination has naturally introduced much confusion into the literature of the subject. It has also prevented the diffusion of correct ideas respecting the mode of origination of the several and totally distinct species of parasites that are thus incongruously blended under a

single title. We cannot now abandon the general term; yet, when not addressing the helminthologist, it is desirable to offer some distinctive prefix, in order to characterise the particular hydatid referred to. The first of the three bladder worms in question is the common hydatid. This parasite is almost as abundant in cattle as in sheep, and it has been described by naturalists under

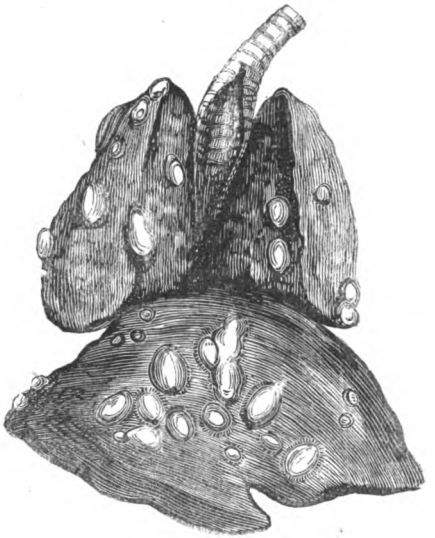

Fig. 12. HYDATIDS ENCYSTED WITHIN THE LUNGS AND LIVER.

upwards of twenty different names. It is best known to us as the *Echinococcus veterinorum*. It infests mankind, monkeys, equine animals, and all ruminants. Specimens have also, it is said, been obtained from felines and rodents, and the distinguished zoologist Von Siebold also described an example taken from the lungs of a turkey.

The annexed and much-reduced illustration (Fig. 13), which unfortunately fails to do justice to the original

coloured and life-sized figure, is copied from a careful drawing made by the late Mrs. Cobbold, of Holywells, Ipswich, Sept. 9, 1818. It supplies, nevertheless, a tolerably characteristic representation of the echinococcus disease as it shows itself in the lungs and liver of the sheep. Occasionally the hydatids are very much more numerous in the lung and liver than this figure actually represents them to be. On the 22nd of May, 1873, I had an opportunity of exhibiting to my class a remarkable example of the lungs and liver of a sheep, in which there were several hundred cysts, so densely packed together as to leave very little healthy lung and liver tissue. Nevertheless the animal from which the diseased organs were obtained was very fat, and had not displayed any symptoms of the disease. The animal was sent from Norfolk, and was slaughtered for the London market in the ordinary way; no suspicions having arisen as to the presence of internal parasites.

The literature of hydatid, or echinococcus disease, as it manifests itself in the human bearer, is of enormous extent; and this will not be wondered at when it is considered that this parasite occasions not less than one-sixth of the entire annual mortality in Iceland. In this country also very many persons perish of the hydatid disorder, but it comparatively rarely proves fatal to cattle. So incomplete, however, are our records in respect of the prevalence or otherwise of the common hydatid amongst oxen, that it is difficult to draw any satisfactory inferences on this head.

Experimental researches conducted by Von Siebold, Leuckart, Küchenmeister, and others, have clearly established the fact that all genuine forms and varieties of the common hydatid are merely the larval stages of growth of a minute tapeworm which resides in the dog (*Tænia*

echinococcus). In this country Mr. Edward Nettleship succeeded in verifying the results thus obtained abroad. My own prior experiments, however, from causes elsewhere explained, yielded only negative results. It must be added that the history of the development of this entozoon is one of remarkable interest; but (partly from the extent of the subject, and partly from its more obvious importance in connection with the parasitism of dogs and sheep) I purposely omit further details on this score for the present.

Hydatids—apart from those producing "gid," or sturdy —are not merely a cause of disease in cattle, but also occasionally of death. In this connection it is much to be regretted that so few of the many cases occurring in veterinary practice are placed on record. In the *Veterinarian* for 1838, Mr. J. Stoddard gives the case of a cow where the liver was, after death, found to be "occupied with numerous hydatids;" yet it does not appear certain that the extensive inflammatory action, which proved the immediate cause of the animal's death, had its origin from the parasites. In a somewhat similar case, however, recorded by Mr. J. Barnett in the same journal for 1865, there can be no doubt that the death of the bovine patient resulted from the injurious action of the entozoa. In this instructive case the liver contained multitudes of echinococcus vesicles, varying in size "from that of a marble to a small egg." The quantity of pale-coloured fluid contained in the smaller and larger vesicles collectively amounted, we are told, to "upwards of two gallons." A third case of a similar kind, seen by Mr. Meek, is also alluded to in Mr. Barnett's communication.

It is well known to surgeons, helminthologists, and others, that not merely the soft tissues, but even the

bones of men and animals, are liable to be invaded by these bladder worms; and I may mention the singular circumstances that no less than nine instances have been brought under my notice where the hydatid had lodged within the shaft of the human tibia. In the case of animals such occurrences must be rare; nevertheless, John Hunter secured two remarkable examples of this parasite from the bones of oxen. In one animal an echinococcus vesicle occupied the humerus; whilst in another several "acephalocysts" were seated within the iliac bone. These remarkable specimens are still preserved in the museum of the Royal College of Surgeons, Lincoln's-inn.

The abundance of common hydatids, or acephalocystic bladder worms, in cattle has already been alluded to; and my correspondent Dr. Joseph Fleming rightly accounts for their great prevalence by referring to the multitude of dogs which frequent the Indian villages. He says:—"I calculated there must be one dog to every four inhabitants, and I considered it strange that these dogs had no owners. In short, they appeared to form independant colonies in every village." I will here only further add, that the true relation subsisting between these bladder worms and the echinococcus tapeworm will be more fully shown in the sequel.

The Slender-necked Hydatid.—This parasite (*Cysticercus tenuicollis*) is far less abundant in the ox than in the sheep. Its presence in the bovine bearer often escapes observation, chiefly because the parasite rarely occasions inconvenience to the host. As I shall show, however, when treating of the entozoa of the sheep, the slender-necked hydatid is sometimes capable of causing inflammatory action, especially when it takes up its abode in the

liver. Not only does this parasite infest ruminants, but it likewise invades the viscera of other kinds of mammalia, including monkeys, and even man himself. In its adult condition it forms one of the numerous tapeworms resident in the dog (*Tœnia marginata*). This is the bladder worm which Dr. Möllar swallowed in the fresh state, hoping thereby to rear within his own intestinal canal the adult representative worm in its cestoid condition. The result was negative; and it farther appears that the dog, and the dog only, constitutes the proper ultimate bearer of this large larval tapeworm. In this reckoning, however (and in accordance with the generally accepted view that dogs have descended from wolves), we have to include the dingo, every other variety of wild dog, and also the wolf.

The Many-headed Hydatid.—As a fertile cause of "gid," or sturdy, in sheep, this common helminth has acquired notoriety, and it is well known to parasitologists under the title of *Cœnurus cerebralis*. When treating of the ovine entozoa I shall necessarily dwell at some length upon the general structure and development, and also upon the ravages committed and the symptoms set up by this bladder worm when lodged in the brain of the sheep; but in the meanwhile it is proper to notice that the *cœnurus* not unfrequently gives rise to sturdy in cattle.

Up to comparatively recent times, the records of sturdy, or turnside, amongst English cattle have been—to use an expression employed by the late Mr. Youatt—"disgracefully scanty." We mean by this to say that, considering the abundant proofs which veterinary practitioners could supply respecting the occurrence of hydatids in the brains of calves, heifers, or cows, it is a great pity

more of such interesting cases have not been published. As in sheep so in cattle, one of the most striking symptoms is the peculiar rotatory movement of the affected beast. Staggering, vertigo, sudden starting, inability to straighten the neck, difficulty of grazing, and subsequent impairment of vision are amongst the other characteristic phenomena of the disease. Cases are not wanting, however, in which a similiarity of symptoms may occur from other agents that are capable of producing symptoms of chronic compression of the brain.

As early as the year 1661 the parasitic nature of sturdy was recognised; for, according to Youatt, Bartholin relates that in the year in question a "great many beasts perished from a species of frenzy, and that when they were examined vesicular worms were found in the substance of the brain." Occurring rather more than a century later (1792), I find an interesting paper by Moorcroft (in the third volume of a serial entitled "Medical Facts and Observations") concerning the production of "hydatids in the right anterior ventricles of the brain of a cow;" and during the present century many such like cases have been published, especially in France. The instances recorded, however, bear no proportion to the number of cases which have been observed.

Reserving my special account of the peculiarities presented by the entozoon itself, I have in this place further to remark that amongst the more interesting cases on record are two by Duplene. In the case of a two-year-old heifer (and without being able to diagnose the precise seat of the hydatid) he operated with perfect success, saving the animal's life at a time when it was well-nigh moribund; and in the second case, that of a sturdied bull, the operation for removing the parasite was also

attended with equally successful results. In both cases the bladder worm occupied the right side of the brain. The cases were especially instructive, as showing the folly of waiting to take active measures until evidences of absorption of the cranial bones indicate the precise seat of the parasite; and further, the particular case of the heifer shows that, notwithstanding the setting in of the severest cerebral symptoms consequent upon the operation, the animal may eventually make a good recovery (*Veterinarian* for 1836, p. 115). Mr. Youatt alludes, without any precise reference, to a paper read before the Medical Society of Toulouse, in which the author refers to a practitioner "who had operated on cattle twelve times for the extraction of the hydatid, and eight times out of the twelve with perfect success;" whilst the author of the communication exhibited to the meeting two specimens of the worm which he had himself removed from the brain of a heifer eighteen months old (*Veterinarian* for 1834, p. 575.)

Of the other cases of interest collected from foreign sources, we have that of Hering, who found no less than seven imperfectly developed *cœnuri* in the left hemisphere of the brain of an old cow affected with sturdy; that of Patellani, where hydatids in the right ventricle of the cerebrum occasioned the death of a two-year-old heifer; and that of Ramoser, where a one-year-old heifer was trephined, but was slaughtered the following day, when it was found that the worm had occupied the right lateral ventricle. Lastly, in the *Veterinarian* for 1865 (p. 357), Mr. J. Cooper records three cases of *cœnurus* occurring in calves. In this connection I have further to remark that the generally received notion that bladder worms and

other parasites can only infest young animals is entirely erroneous. No doubt they occur more frequently in juvenile bearers, but that old animals enjoy a perfect immunity in this respect is far from being the case. In his treatise on "Diseases of the Ox," Mr. Youatt remarked that the *cœnurus* "occurs only in the young animal;" but the case of Hering, above quoted, is alone sufficient to disprove the perfect accuracy of the statement. I am not quite sure that it is even correct to say that these parasites are less common in the cattle of England than in the herds of other adjacent countries; yet I have reason to believe that this opinion is widely entertained by leading members of the veterinary profession. My impression is that the greater readiness of the Continental practitioners to come forward and publish their cases of sturdy, accounts in a great measure for the assumption that the disorder is more frequent in other parts of Europe than with ourselves. At all events, it is gratifying to learn that the trephine is employed with remarkable success abroad, especially in Bavaria. Cases of successful trephining for sturdy have been brought under my notice; and it only remains for me to repeat to a larger professional public the suggestion I have often made to my class, that all such cases should be placed on record. The necessary facts can be stated in a very few words.

CHAPTER VII.

ROUND WORMS OF THE OX—THE SMALL TAILED STRONGLE GIVES RISE TO HUSK, OR HOOSE—REMEDIAL MEASURES DEMANDED—WHAT IS REALLY REQUIRED—FIVE SPECIES OF STRONGLE INFEST CATTLE—THE TOOTHED PENTASTOME—ENTOZOA OF THE SHEEP—OUTBREAKS OF ROT—PROF. SIMOND'S MEMOIR—OCCURRENCE OF ROT IN AUSTRALIA—DR. ROWE'S EXPERIENCES—WATERY MUTTON COMPARATIVELY INNUTRITIOUS—CAN THE ROT BE STAMPED OUT?—RADICAL CURES AND PALLIATIVE MEASURES FAIL IN ADVANCED CASES—TAPEWORMS IN SHEEP—EPIDEMIC IN LAMBS RECORDED BY MR. COX—GID, TURNSIDE, OR STAGGERS—PATHOLOGICAL INDICATIONS—CŒNURI NOT CONFINED TO THE BRAIN—BLADDERY RABBITS—TREATMENT OF GID—THE MUTTON MEASLE.

THE completion of my account of the cestode parasites of the ox enables me to say a few words respecting the threadworms, strongles, and lumbricoids infesting this animal; and since their importance (in connection with bovine diseases in general, and with hygienic matters in particular) is by no means equal to that of the tapeworms, it is unnecessary to dwell at any great length upon the natural-history peculiarities displayed by the various individual forms. The species of worm which gives rise to husk, or hoose, in cattle may be appropriately termed *the small-tailed strongle*. This parasite is known as the *Strongylus micrurus*. The female measures about 3in.

from head to tail; but the male acquires only half that length. As obtains with the other members of the family (*Strongylidæ*) the males have a kind of hood at the end of the tail. Males and females alike infest the *bronchi* of calves; their presence being productive of fatal mischief by blocking up the air passages.

A great deal has been written about husk, but what is wanted is less recapitulation of well-known facts, and greater knowledge of the causes which produce the disease. Agriculturists are for ever demanding a remedy, and the reply they obtain is practically to the effect that, except in the earlier stages of the malady, remedies are well nigh useless. One practitioner speaks highly of turpentine, another of salt, a third of assafœtida, a fourth of fumigations, and so on; each repeating year after year the time-honoured experiences of his predecessors. There can be no doubt as to the efficacy of chlorine gas inhalations in young animals; and I have the pleasure to remark that a former pupil of mine, Mr. A. G. Leany, has recently employed this method of treatment with great advantage in the case of fifteen heifers. He had previously made a successful diagnosis from the symptoms alone.

Speaking of the lamb disease, a writer in the *Gardener's Chronicle* asks, "Cannot some scientific person think of a means of destroying these parasites by way of an application to the pastures where the disease is known to abound?" We reply to the effect that "any application to the soil which shall be effectual in destroying the young parasites would prove injurious to the herbage." What we require is a series of investigations (by some competent person), which, in their results, shall afford a clue to the proper preventive measures to be

taken by stockowners and agriculturists. In the mean time, amongst the best remedial measures we should place all those which tend to support the system. Remove the animals to high and dry grounds; give bran mashes and other artificial food: house the beasts if it be cold; in severe cases give gruel of wheat-flour, and if there be excessive "scour" check it by the ordinary sheep and calves' cordial. Give also five or ten grains of squill powder with a teaspoonful of ipecacuanha powder in the common mass, or in gruel, twice or thrice daily; and avoid all violent drugs, since they only tend to lower the patient's strength. Treatment of this description will restore many a beast that would otherwise perish.

Four other species of strongle have been indicated as infesting the calf and ox. These are, respectively, the "swollen strongle," which occurs in the small intestine (*Str. ventricosus*); the "inflated strongle," occupying the large intestine (*Str. inflatus*); the radiated strongle, found in the gall ducts (*Str. radiatus*); and the giant strongle (*Str. gigas*) whose right to be considered a true bovine parasite is disputed by some helminthologists.

Lastly, I may mention that there is yet another interesting little entozoon, not strictly belonging to the helminths, which alike infests the ox, the sheep, and herbivorous quadrupeds generally. This is the "toothed pentastome," or *Pentastoma denticulatum*, whose adult representative resides in the dog. It will, therefore, more appropriately engage our attention when we discuss the parasites proper to that animal.

Parasites of the Sheep.

For the most part, the ovine entozoa comprise the

same forms as those found inhabiting the ox; and therefore, taking them in the same order for description, I need only to add such particulars as were purposely omitted in my account of the parasites of the ox. In this connection it will be remembered that I spoke of the ravages of the "common liver fluke," describing the rot disorder as much more disastrous to flocks of sheep than to herds of cattle.

It is a mistake to suppose, as some do, that the larger beasts rarely succumb to the fluke disease. The earlier outbreaks which took place in the Duchy of Coburg in 1663 and the following years were remarkably fatal, not only to sheep, but also to cattle, deer, and hares. The Dutch outbreak in 1674 affected nearly all the cattle of Zeeland. The French epidemic of 1829 destroyed cattle in great numbers; for, in the district of Montmedy alone, Davaine tells us that 5000 horned cattle perished; a similar fate overtaking more than one-half of all the sheep grazing in that district. As to the English outbreaks, they have been quite as severe as regards sheep, but it does not appear that our cattle have suffered to the same extent. Be that as it may, I feel it quite unnecessary to enlarge upon this point; and the more so, because all who are interested in the matter can readily obtain Professor Simonds's valuable memoir or the "Rot in Sheep," and in this small treatise they will find the history, progress, symptomatology, and treatment of the disease discussed in a masterly and thoroughly exhaustive manner.

I am here chiefly concerned to open out to view certain hygienic and other particulars which bear more or less strongly upon the sale of meat; but as regards the general food question, and apart from the parasitic phase

of the subject, I can only remark, in passing, that valuable articles on this subject have appeared in the *Manchester Guardian* and in *Chambers's Journal*. The subsidiary question as to the alleged diminution of cattle and sheep over large areas devoted to the rearing of game has also received ample attention in the pages of the *Field*.

Limiting myself to the injurious results of parasitism in relation to the supply of flesh for food, I have at once to declare my conviction that the supposed disastrous effects from this source have been greatly overrated, and further, that it is altogether a mistake for inspectors to condemn as unfit for human food meat which has been taken from rot-affected sheep. In this view I am cogently supported by the statements of Dr. Rowe, a large sheep farmer, who, writing in the *Melbourne Leader* for Oct. 19, says: "The mere presence of flukes in the viscera of any animal is no proof that it is unfit for human food; and for the inspectors of slaughterhouses to adopt such a test of wholesome food would be a great mistake. It would afford no protection to the public against unhealthy food, would increase the price of animal food, and be ruinous to our farmers and graziers. If the consumption of fluky beef and mutton were prejudicial to the health of man, there would be very few people alive in this part of the colony; for, to my certain knowledge, they have had no other animal food to live upon for the last twenty-five years; and for physical ability I believe they may be compared favourably with any other part of Australia."

Exactly so. Everyone is prepared to admit that watery (or what Dr. Rowe calls "fluky") mutton, procured from animals which are far gone in the disease, cannot be either

very palatable to the taste or highly nutritious; but when it is considered that such a state of things only occurs in sheep which are very rotten, there can be no valid reason for rejecting meat derived from animals slaughtered before that period of exhaustion arrives. It is well known that sheep fatten readily during the initiatory stages of the disorder; and, guided in his conduct by this knowledge, Dr. Rowe can say, "I have fattened thousands of them, and converted them into money within six months after their arrival." On a smaller scale some of our own sheep breeders have been equally successful.

The possibility of stamping out the disease is a question to which Dr. Rowe has also applied his practical mind very diligently; and, accepting my views as to the genesis and development of flukes, he suggests the adoption of a series of measures which he believes might effect this desirable end. It is unnecessary to recapitulate his statements at length, since they have been reproduced quite recently in the pages of the *Veterinarian* (for Feb. 1873.) Suffice it to say that the main point consists in burning the grass on which "fluky" sheep have been pastured, and thereafter restocking with sound animals. This step, along with others of a subordinate kind, would ultimately have the desired effect; but the expenses necessary to cover the losses incurred in the first instance would necessarily operate to prevent their adoption on any very extended scale. All things considered, therefore, I think that there are simpler precautionary measures, the employment of which would involve only a comparatively trifling outlay. Some of these, at all events, might well form the basis of an experimental test, undertaken with the view of ascertain-

ing the best mode of arresting or annihilating the rot epidemics of the future.

As to the means of effecting radical cures (in cases where the ovine patients already exhibit the pendulous abdomen or protuberant belly, the razor-back condition of the spine, the tottering gait and œdematous state of the subcutaneous tissues, dryness of the skin and falling off of the wool, general emaciation and commencing scour, together with other equally characteristic symptoms), it is quite useless and a mere waste of money to adopt any of the much-vaunted nostrums, or even the less empirical methods of treatment which have been so urgently recommended. In such cases the best palliative measures fail; while such abominations as soot, assafœtida, turpentine, oleaginous mixtures, and even the exhibition of the usually valuable salines themselves, only tend to hasten the fatal result.

Finally, in regard to other flukes found in the sheep (*Distoma lanceolatum* and *Amphistoma conicum*), I have only to add that at present we have no certain evidence as to the powers they severally possess of proving injurious to their ovine bearers.

Tapeworms in the sheep are not of common occurrence; nevertheless they occasionally make their appearance in numbers sufficient to cause a fatal epizootic. So far as I am aware, only one species of cestode (in the adult condition) is known to attack sheep; this is the "long tapeworm," or *Tænia expansa*. On the Continent this entozoon seems to be more prevalent than it is with ourselves; but accurate information is needed on this part of the subject, as well as upon the development of the parasite. As regards its occurrence in England, what we do know is chiefly due to the account

given by Mr. Cox, V.S., whose description of the outbreak amongst lambs in 1855 has already been referred to.

As sheep and cattle are not flesh-feeders in any legitimate sense of the term, we are almost certain that the *cysticerci* of the "long tapeworm" cannot, as measles, be found in the muscles of any vertebrated animal; and it is therefore almost certain that some of the small molluscs and insects found in water or in damp situations

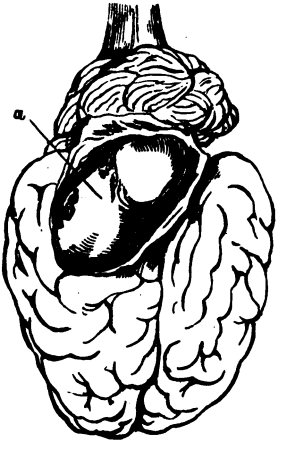

Fig. 14. Upper Surface of the Brain, showing an Hydatid.

constitute the intermediary bearers of the tapeworm larvæ in question.

Of the various cestode larvæ which, as such, infest the sheep, by far the most important one is that which gives rise to "gid," "turnside," or "staggers;" and, as already explained, this so-called *Cœnurus cerebralis*, or many-headed hydatid, is the juvenile stage of growth of a tapeworm infesting the dog. Its development will

engage our attention when describing the canine entozoa; but meanwhile, in addition to data already advanced when speaking of the "sturdy" as it exists in cattle, I have to remark that this larval entozoon usually occurs singly in the brain of its host. That several of these parasites occasionally gain access to one animal is a matter of professional observation; nor need the fact excite any particular remark, except in so far as it disturbs the commonly-received opinion as to the usual seat

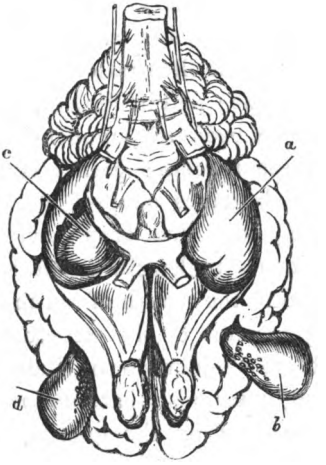

Fig. 15. Base of the Brain, displaying four Hydatids.

of the entozoon at the upper part of the brain. Ordinarily the parasite attacks yearlings, but it is an error to suppose that animals of three years old and upwards are incapable of taking the disease.

As to the symptoms of "gid," it is unnecessary to repeat them.

When, after death, the skull of a sturdied sheep is laid open (the brain at the same time being carefully re-

moved), the appearances are commonly such as are here represented from Numan's admirable treatise "*Over den veelkop-blaasworm der hersenen.*"

In Fig. 14, *a*, we have a single large *cœnurus* occupying the upper and posterior part of the right cerebral hemisphere, whilst in Fig. 15, *a*, *b*, *c*, *d*, no less than four hydatids are seen projecting from the base of the brain, two in front and two behind, being almost equidistantly separated from one another. The hydatid usually varies in size from a pea to that of a pigeon's egg, but in some instances they are as large as a hen's egg.

I may remark that the illustrations are reduced to one-half of the natural size; and in Fig. 14 the letter *a* refers to a cyst which has been left unopened. When, in the living animal, these parasites gain access to the spinal canal, their form becomes adapted to the peculiarities of their situation; and thus they have been found to grow to several inches in length. One such example is figured by Numan to the length of ten inches.

Reserving my account of the structure, development, and destiny of these bladder worms, I may remark that it is quite a mistake to suppose that *cœnuri* can only reside in the brain. Passing by the question as to whether those found elsewhere may not turn out to be the larvæ of several distinct species of tapeworm, I will only observe here that I have myself discovered *cœnuri* in the viscera of an American squirrel, and also in the lungs of a Madagascar lemur. Mr. C. B. Rose, of Norfolk, was the first to discover them in the flesh of conies, which the warreners not inappropriately termed "bladdery rabbits;" and M. Baillet has since obtained a *cœnurus* from the pectoral muscle of the same rodent.

Professor Leuckart states that Eichler found a *cœnurus* "of the size of a goose's egg in the subcutaneous cellular tissue of a sheep," and, according to Numan, Engelmeyer, V.S. at Burgau, found one in the liver of a cat. As will further appear in the sequel, these facts are too important to be passed over; and their significance in relation to the strictly hygienic aspect of "gid parasitism" can only be thoroughly appreciated when we shall have discussed the developmental history of the corresponding tapeworm which lives in the intestines of the dog (*Tænia cœnurus*).

In regard to treatment, it is satisfactory to know that Parkinson's brutal method of cutting off the ears of affected sheep close to their sockets, and the scarcely less barbarous mode of puncturing through the nostrils, as advocated by the Ettrick Shepherd, are plans which seldom find favour nowadays; and when we consider the terrible injuries inflicted by James Hogg's method of operating, one need not be surprised at his admission that some of the animals thus operated on do "die in the greatest agonies, and groan piteously." The direct mode of puncturing commonly pursued by veterinarians is so simple, so well known, and so fairly successful on the whole, that it is quite needless to enlarge further upon its merits, whether the awl, the trephine, or any other instrument happen to be employed; but I may conclude by remarking that, similar principles of treatment are equally effectual in the case of those many-headed hydatids which occupy the soft parts of animals. Thus, as Mr. Rose somewhat humourously observes, "when the warrener meets with a rabbit thus affected, he punctures the tumour, squeezes out the fluid, and sends the animal to market with its brethren." For the comfort of con-

sumers, it may be confidently added, that all such bladdery "conies," whether much or little cooked, are quite incapable of giving rise to parasitism in those persons who partake of them.

Respecting certain other larval tapeworms which infest sheep, all I need say is, that we find the "common hydatid" and also the "slender-necked hydatid" rather more abundantly in ovine than in bovine bearers. The facts of their development will more naturally come under my record of the canine entozoa; but a few words must be said in reference to a recently-discovered entozoon, which I have elsewhere termed the Mutton Measle.

This larval tapeworm (*Cysticercus ovis*) resembles that found in pork, inasmuch as its head is armed with a double crown of hooks. On two or more occasions I have detected degenerated measles in joints of mutton brought to table, and Dr. Kirk appears to have observed similar cysts in Africa; whilst Professor Heisch gave me the loan of a nearly perfect specimen which he had himself procured from the interior of a mutton chop. The last-named example was some time ago figured in the supplement to my larger treatise on entozoa, and I have since attempted, by experiment, to ascertain the form of the adult tapeworm representative of this new and little-known larval parasite. At present my efforts in this relation have only been attended with negative results; but I feel quite satisfied that the *Cysticercus ovis* is specifically distinct, not merely from the corresponding unarmed measle of cattle, but also from the armed *cysticercus* of the pig.

I see it stated (in *Nature*, for May 15, 1873, p. 59) that Dr. Maddox has also found an encysted parasite in

the neck of a sheep, which is believed to belong to the *Tæniæ*. As we are told that "the presence of immature ova was particularly noted," it is to be feared that Dr. Maddox has mistaken the oval calcareous corpuscles so common in these cestode larvæ, for eggs. It is incredible that a cystic tapeworm should display ova in any stage of development.

CHAPTER VIII.

NATURE OF THE LAMB DISEASE—HARES SIMILARLY AFFECTED—THE COMMON LUNG STRONGLE—THE LONG STRONGLE—THE MAIN QUESTION FOR AGRICULTURISTS—EIGHT SPECIES OF NEMATODE WORMS INFEST THE SHEEP—BOTS AND PENTASTOMES NOT TO BE CONFOUNDED—ENTOZOA OF THE DOG—WHY SO IMPORTANT—FLUKES ABUNDANT IN THE PARIAH DOGS OF INDIA—THE COMMON LUMBRICOID WORM OF THE DOG—ITS PREVALENCE IN EUROPE—SYMPTOMS IT MAY OCCASION—ANTHELMINTIC REMEDIES—SANTONINE, ARECA-NUT POWDER, CALOMEL, AND TURPENTINE—CAUTIOUS EMPLOYMENT OF THE LATTER NECESSARY—HYGIENIC MEASURES RECOMMENDED.

IN order to complete my *résumé* of the facts of parasitism shown to occur in the sheep, it is needful to speak of the part played by the nematodes, or round worms; and chiefly so, since one or two of the numerous species of strongle are productive of severe epidemics amongst ovine bearers. What is commonly called "the lamb disease" is simply the equivalent affection of husk, or hoose, occurring in cattle; and it may also be said that essentially the same verminous lung-disease, though brought about by the injurious action of other forms of the round worm group, carries off various domesticated animals, and even also wild ones, especially hares. Such an epidemic affecting rodents occurred in Thuringia in 1864, as re-

corded by Sollmann in the *Coburger Zeitung*. The well-known lamb-disease, though generally supposed to be due to the presence of a single species of worm called the Common Lung Strongle, or *Strongylus filaria*, is in reality due to the occurrence of at least two different parasites belonging to the same group. For years past it has been known to Continental helminthologists that a second species of nematode worm is usually associated with the above-named parasite, the form in question having been originally described by Professor Leuckart, under the title of *Strongylus rufescens*. I am the more desirous of calling attention to this fact since Dr. Crisp (an earnest worker in the cause of parasitology) believes that he has discovered a new worm in the lungs of lambs and sheep, which he calls a *Gordius*.

I entertain no doubt that Dr. Crisp's gordian worm is the adult representative of the immature worm found by Professor Brown some years ago; fresh specimens having also recently been examined by Mr. Axe and myself. This so-yclept gordian worm is a large species of strongle, which, in contradistinction to the common lung strongle, I am in the habit of speaking of as the Long Strongle; and I think this designation is particularly convenient, because the parasite, in its full-grown state, acquires a length of from six to seven inches, or, as Leuckart affirms, it may be a span long.

Dr. Crisp conjectures that his "*gordii* ultimately become the *strongyli*," and in this assumption of genetic relationship he is probably correct when speaking of the young, although such a developmental connection could certainly not obtain if it were true that his supposed new worm were really a *Gordius*.

The Danish helminthologist (Dr. Krabbe, of the Copen-

hagen Veterinary School), referring to this entozoa, says, "In the condition of thin-shelled eggs and free embryos, they either lie in the windpipe or they occupy the cavities of the finest bronchial tubes; and in these situations they not unfrequently set up inflammatory action, with more or less obliteration, thus rendering the lungs impervious." (Husdyrenes Involdsorme, *Tidsskrift for Veterinairer*, 1872.) In a similar way, the adult forms of *Strongylus filaria* occupy the *bronchi*, chiefly those of medium size; and here, as remarked by Leuckart, they either produce a simple catarrh, or set up an inflammation which "diffuses itself over a great part of the lung, ultimately causing death."

The question which agriculturists should be chiefly desirous of solving is that appertaining to the mode of origination and development of these parasites; for, by acquiring accurate data on this head, it is not altogether unreasonable to suppose that we may hit upon a more or less perfect method of limiting or eradicating the disastrous epizootic associated with an excessive multiplication of these creatures during particular seasons. In the present nascent and imperfect state of our knowledge respecting the phenomena in question, I purposely forbear to utter all that I might advance respecting their prophylactic bearings; yet I trust that the various agricultural societies will appreciate the importance of the foregoing data in relation to the practical interests they have justly so much at heart. One society, indeed, has involved me in a lengthened correspondence on this subject.

As regards certain other nematode parasites, it is only necessary to state that the sheep is infested by at least six more species, making in all eight ovine nematodes.

These may be enumerated briefly as the twisted strongle (*Strongylus contortus*), itself capable of producing an epizootic; the slender-necked strongle (*Str. filicollis*); the bent strongle (*Dochmius cernuus*); and the rigid strongle (*D. hypostomus*). In addition to the strongles we find the common whipworm of ruminants, or *Trichocephalus affinis*, in great abundance; and, as I have already shown, it appears to be capable of producing severe symptoms in the ovine bearer. In the illustration (Fig. 16) the letters *a* and *b* severally refer to the male

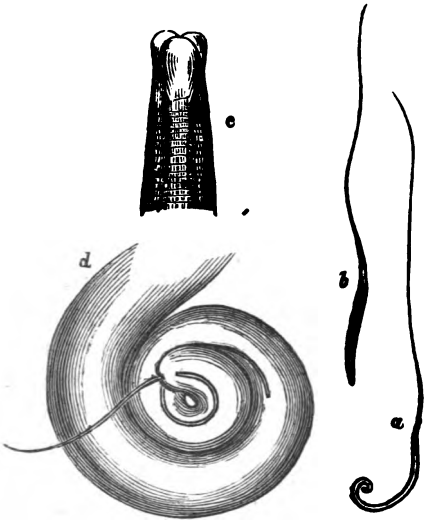

Fig. 16. THE WHIPWORM OF RUMINANTS.

and female worms of the natural size, whilst *c* gives a highly magnified view of the head and neck; the spirally curved tail of the male parasite being represented at *d*, with its long and sheathed spicule protruding from the cloacal outlet.

A species of Ascaris has been described as occurring in

the sheep, but much doubt is entertained respecting its precise character. My impression is that it is none other than the common *Ascaris lumbricoides*, which I have already spoken of in connection with the nematodes of cattle. Lastly, if it be asked whether the little *Trichina spiralis* ever occurs in mutton, the reply must be to the effect that, up to the present time, no one has seen it in the flesh of sheep. Nevertheless, it is just possible that it might accidentally infest this animal in some one or other stage of its life-cycle, seeing that Professor C. J. Fuchs and H. A. Pagenstecher, by means of experiments conducted at the Zoological Institute of Heidelberg, succeeded in rearing three mature *trichinæ* in the intestinal canal of a goat.

Although not strictly a helminth, I must also mention that the *Pentastoma tæniodes*, an arachnidan parasite, is sometimes encountered in the frontal sinuses of the sheep. This is the adult form of the *Pentastoma denticulatum*, already noticed in connection with cattle. In the full-grown state it likewise infests the dog, and will again occupy our attention in due course. It must not be confounded with the "bot," or larva, of *Œstrus ovis*, which also resides in the nasal and frontal sinuses. It is a common opinion amongst farmers that this "maggot," as they term it, actually gains access to the sheep's brain. Some persons will get very angry if told that such an occurrence is quite impossible.

From the amount of space that I have devoted to the consideration of the parasites of the ox and sheep, it might naturally be concluded that these animals are more subject to entozoal attacks than other domesticated quadrupeds, such, for example, as the horse, pig, and dog. This notion, however, if entertained, is by no

means a correct one; but I have, thus far, purposely dwelt at great length on those forms of entozoa which are in some sense or other injurious in their action upon mankind, through the medium of certain of our domesticated animals.

With this brief explanation I pass on to notice the Parasites of the Dog.

It is surprising what a number of entozoa infest the dog; and it is still more remarkable to observe what a number of creatures, including man himself, are destined to play the *rôle* of intermediary bearer of the canine parasites in their juvenile stages of development. It is this consideration which to my mind renders the dog, in the matter of parasitism, far more important than any other domesticated animal that can be named.

It is not a little singular that a trematode parasite which I had the good fortune to discover at the Zoological Society's Menagerie fourteen years ago has recently been re-discovered, so to speak, in India. The worm in question may be termed the Conjoined Fluke.

This species (*Distoma conjunctum*) was originally obtained by me from the liver ducts of an American red fox (*Canis fulvus*), in which situation it had given rise to inflammation and the formation of small cysts or abscesses, apparently causing the death of the host. Its average size was about one-fourth of an inch in length. Evidently speaking of this entozoon, Dr. Lewis remarks that it is "not unfrequently met with in the bile ducts" of the pariah dogs of India; moreover, if the accompanying illustration (Fig. 16, *a*; reduced from a drawing by Dr. Lewis) be compared with that given in the second plate of my larger work, it will be clearly seen that the specific identity of the worms is complete. It is true that,

in the first instance, I overlooked the existence of minute spines (*b*) which clothe the surface, yet I have since recognised them in my specimens. The eggs (*c*) are oblong, and more or less narrowed at the anterior pole, which is furnished with a lid to facilitate the subsequent escape of the embryo. I have said thus much about this parasite because of the novelty of its discovery in India, and the probability of its occurrrence in many parts of the world. There is another fluke which might

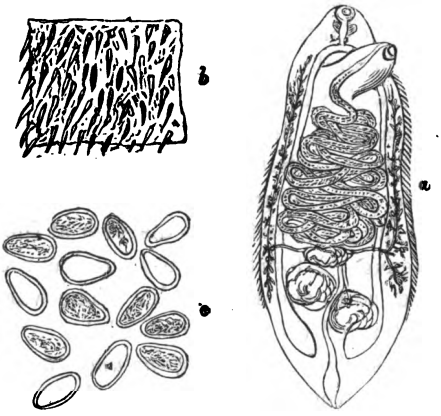

Fig. 17. THE LIVER FLUKE OF THE DOG.

readily be mistaken for the above. This is the winged fluke (*Holostoma alatum*), occasionally found in the stomach and intestines of the dog, but more commonly in the alimentary canal of the fox.

When people speak of "worms" in the dog, they commonly refer to round worms and tapeworms; and in place of recognising, as they might, fully a score or more of internal parasites, they are content to roll the entire series into three or four species only. It is the function of the helminthologist to correct this error. Thus, of the

so-called lumbricoid and filariform worms we have no less than eight or nine distinct forms, and of these the most common species is the Margined Round Worm.

This lumbricoid of the dog (*Ascaris marginata*) is probably identical with the moustached worm of the cat (*Ascaris mystax*). It is sometimes described as the long round worm. The males acquire a length of from two to nearly three inches, whilst the females measure four, five, or even six inches from head to tail. To afford some notion of its prevalence, I may state that it was found at Vienna in 104 out of 144 dogs dissected for the purpose; and Dr. Krabbe obtained it at Copenhagen in 122 instances from the *post-mortem* examination of 500 dogs. According to my own experiences, it occurs in English dogs at the rate of about 70 per cent. Occupying principally the small intestines, but often wandering into the stomach, and occasionally also making its way into the throat and nostril, this parasite is a frequent source of severe intestinal disturbance, sometimes producing even death itself. Cats and dogs alike are constantly throwing them up, and it is a great relief to the host when they are thus dislodged. Their occasional passage by the ordinary outlet is also a matter of common observation; but it is not so very generally understood that these modes of egress are often the result of a voluntary wandering on the part of the guest. This is practically of some moment, because it accounts for the circumstance of their being sometimes found in the nasal passages and in other unusual situations. The formidable nature of the symptoms which may thus be superinduced have been fully indicated in a letter of mine which appeared in the *Field* for Dec. 21, 1872. Under ordinary circumstances, the symptoms in the dog are those of irregular intestinal

action, accompanied with nausea and spasmodic colic, irritation, a voracious appetite, and more or less loss of flesh. In addition, there may be fœtor of the breath, accompanied by a short, husky cough and an impoverished state of the coat; and, either with or without any of these symptoms, there may be more or less paralysis. I may here make mention of an interesting case of paralysis in puppies brought under my notice by Mr. Lewis (*The Field*, Dec. 7, 1872), in which it was instructive to notice how complete a cure followed the administration of a simple aperient drug. Quite recently also, a correspondent, writing from Ceylon under the signature of "Veddah," gave a suggestive instance where paralysis in dogs seemed to be entirely due to worms (*The Field*, March 15, p. 238).

A great variety of anthelmintics have been recommended; but for this particular worm there is probably nothing better than castor oil and santonine. As with the lumbricoids of man, so with those of the cat and dog; in either case they seem powerless to resist the action of this remedy. In the human subject I have known a grain of santonine sufficient to expel a lumbricoid as large as a lob worm; and in the dog or cat similar experiences have followed the employment of from three to five grain doses. Several of my pupils have adopted this mode of treatment with success. The employment of more powerful vermifuges is rarely necessary; and even the areca-nut powder should generally be reserved for tapeworm. Areca-nut powder is unquestionably a good vermifuge, as I can testify from personal experience; and I observe that it is strongly recommended by "Stonehenge" in his admirable memoir "On the Management of Dogs." It is, however, rather as a tæniafuge than as

a lumbricifuge that the merits of areca-nut powder stand out most conspicuously. The powder may be given in half-drachm or one-drachm doses, followed by castor oil, and repeated twice or thrice in the day. In bad cases turpentine may be cautiously resorted to, and, when given, should be combined with twice as much either of castor or of linseed oil. The dose of turpentine should rarely be more than one drachm, and in no case should it exceed two drachms in the very largest dog. Three drachms of turpentine have been known to occasion violent convulsions in the full-grown dog; and in the case of young puppies such a dose would probably prove fatal. Calomel in one to three-grain doses is a favourite remedy with some; but, considering its varied action, it should only be resorted to when other remedies have failed. The mechanical irritants, such as powdered tin and glass, or even cowhage, should in all cases be eschewed, because they are liable to cause much suffering without entailing any adequate result. It is also worthy of remark that after the expulsion of the worms everything tending to support the system should be employed, in view of restoring the animal to perfect health; and lastly, as a hygienic or prophylactic measure, I would advise the frequent application either of carbolic acid solutions or of salt and water to the flooring of kennels. Furthermore, I would strongly recommend the occasional throwing down of buckets full of boiling hot water, since the performance of this very simple act could not fail to be productive of good results in ways too numerous to be particularised.

CHAPTER IX.

PARASITES OF THE DOG CONTINUED—THE CRUEL THREAD-WORM—ITS OCCURRENCE IN CHINA, JAPAN, AND AMERICA — SPECIMENS PROCURED BY MESSRS. SWINHOE AND DARE—OBSERVATIONS BY MR. WELCH—DR. LAMPREY'S STATEMENTS—VARIABLE CHARACTER OF THE SYMPTOMS—DEATH SOMETIMES PRECEDED BY EXTREME SUFFERING—MICROSCOPIC HÆMATOZOA OF GRUBE AND DELAFOND—THE GIANT STRONGLE—NAMES AND HABITATS OF SEVERAL OTHER NEMATODES LIABLE TO INFEST THE DOG—ANOTHER SPECIES OF CANINE HÆMATOZOON—STATEMENTS OF PROFESSOR LEISERUNG.

THERE are many other interesting forms of nematode worms liable to infest the dog; but, with one or two exceptions, they do not appear to occasion much inconvenience to the bearer. Perhaps the most important are those which gain access to the organs of circulation, thereby sometimes producing great suffering, and not unfrequently the death of the canine host. Thus, in *The Field* for Feb. 24, 1872, we find Mr. J. Julius Dare writing from Yokohama, and stating that a parasitic disorder of this description is very prevalent and fatal in China and Japan. I had myself long previously received information to the same effect from Mr. Swinhoe, H.B.M. Consul at Amoy, who also sent me a characteristic example of the heart of a dog stuffed with worms, the

animal having "died at Shanghai in the month of April, 1869, after three days of great suffering." I may likewise mention that similar facts were made known to me fully twenty years ago; at about which time also Professor Bennett of Edinburgh was in the habit of exhibiting to his class a preparation of a dog's heart with worms in the interior. Since the time named I have not only had an opportunity of examining the specimens which were sent to the Editor of *The Field* by Mr. Dare, but I have likewise seen those obtained by Dr. Lamprey, some of which Dr. Baird briefly described to the Linnean Society in 1867. The correct and highly appropriate name for this Chinese hæmatozoon is The Cruel Threadworm, or, more strictly, the *Filaria immitis*. I believe it was so named by the eminent naturalist, Dr. Joseph Leidy, of Philadelphia, but I have not seen his original paper.

In this country the parasite has been erroneously considered as identical with the *Spiroptera sanguinolenta*, but the last-named worm does not gain access to the bloodvessels. Misled by the circumstance that M. Bohe-Moreau found a nematode worm in the heart of a wolf (which entozoon was regarded by Diesing as identical with the *Spiroptera sanguinolenta*) I for a time concluded that Moreau's hæmatozoon and the other were one and the same species. At the Liverpool meeting of the British Association in 1870 I partly corrected this error, have since satisfied myself that as regards the "cruel threadworm" we have to deal with a totally distinct parasite.

If a female *Filaria immitis* be removed from the heart of a dog, and be examined with a microscope, the oviducts will be found to swarm with eggs and embryos

in all stages of development. Of this fact I have had abundant proof by the examination of the specimens sent to me by Mr. Swinhoe; but those who desire full details respecting the minute structure of the mature worm and its embryos should consult the admirable paper by Assist. Professor F. H. Welch, of Netley (*The Lancet* for March 8, 1873). Mr. Welch not unreasonably hopes that his record may have supplied data calculated to throw light upon the origin and nature of the nematode blood worms recently discovered by Dr. Lewis in the human body in India.

In regard to facts of practical moment in connection with sanitary matters, I would call particular attention to the statements of Dr. Jones Lamprey, who, writing from China in July, 1865, tells us that "the hearts of native and foreign dogs at Shanghai are *invariably* found to contain these entozoa," and he suggests that the animals may have obtained their parasites from ova of ascarides passed by man. He also remarks that human excrements constitute "the principal food of the native dog," and he asserts that the fæces are "not disliked by the foreign dogs, however well fed." Dr. Lamprey thinks that the presence of the hæmatozoon is only prejudicial to the canine bearer when the animal is out of sorts from some other cause than the parasitism itself. On the other hand, the tenour of Mr. Dare's able communication to the *Field* shows very clearly that it must be the worms, and the worms only, which thus prove fatal to the helpless bearers.

It is not a little instructive to notice from the testimony thus borne by Dr. Lamprey that the canine animals of China participate in the disgusting habits to which I alluded when speaking of the behaviour of Indian

cattle, as observed in the Punjab by Dr. Fleming and others.

The symptoms of the disease are extremely variable, some of the dogs dying suddenly in a fit, whilst others linger and betray evidences of excruciating pain. As to treatment, it is obvious that nothing can be done when the parasites have once got possession of so vital an organ as the heart. Nevertheless, further researches may enable us to suggest prophylatic measures, by which the epizootic may be checked. There is one important point that ought not to remain long unverified. We want to know for certain whether the blood of these dogs contains free embryonic filariæ, and whether such immature worms, if found, correspond or not with the embryos found in the oviducts of the full-grown worms. It is probable that they do, for Dr. Krabbe, in his admirable *résumé* already referred to, states that the worm reproduces viviparously, and that the young are carried along in the circulation. This statement is probably based on Dr. Leidy's observations; and its truth is further borne out by the facts described by Mr. Welch, as well as by my own subsequent and repeated examinations, the results of which I have not yet published in detail. According to Assistant-Professor Welch, the embryos vary very much in size, ranging from the 140th to the 90th of an inch in length; whilst their breadth never exceeds the $\frac{1}{1500}''$, being sometimes as little as the $\frac{1}{4000}''$. The largest eggs Mr. Welch describes as giving a length of $\frac{1}{900}''$; but, on referring to my note-book, I find I have marked one as being $\frac{1}{854}''$. Some of the ova are very much smaller. I mention these few scientific details because they are of some importance in reference to the question of the specific identity of the nematode hæmatozoa found in

eastern countries. Dr. Lewis's recent discovery of similar parasites in the human body in India has called forth the energies of many microscopic observers; and Mr. Swinhoe informs me that Dr. Little, of Shanghai, is especially engaged in studying the structure and development of the cruel thread worm. I may here add, as a result of my own observations, that the tail of the male *Filaria immitis* is furnished with an elegant and transparent membrane or hood, which is supported upon eight oval glandular papilliform rays, four on each side. These are arranged in pairs, the upper two being the largest, whilst the terminal pair are the smallest, and lie a little behind the point where the two spicules emerge. Under the half-inch objective glass they present a beaded and highly attractive appearance.

It seems somewhat strange that neither in the dog nor in the human bearer do the microscopic filariæ appear capable of setting up bad symptoms. Thus, Messrs. Grube and Delafond (who found European dogs entertaining upwards of 200,000 of these minute worms at a time) state that in no case did the infested animals appear to suffer inconvenience. In like manner, as Dr. Lewis tells us, people in India go about with thousands of living embryonic nematode parasites in their blood, and yet do not betray any evidences of suffering.

Though of comparatively rare occurrence in the dog, there is a large lumbricoid worm which deserves a separate notice, however brief. This is the giant strongle (*Estrongylus gigas*) which infests the kidneys of various animals, proving especially destructive to the North American mink (Fig. 18). The males rarely exceed ten inches in length; but the females have been known to exceed a yard in measurement from head to tail, whilst

their thickness equals that of the little finger. The accompanying figure of a female specimen, from Blanchard, is reduced to one-third of the natural size. Specimens of this huge nematode worm are preserved in the Hunterian Museum, and also in the Museum of the Royal Veterinary College.

Of the remaining round worms of the dog, I need do little more than indicate their names and special habitats.

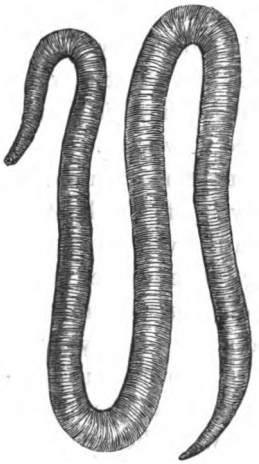

Fig. 18. The Giant Strongle.

Thus, the blood-red species (*Spiroptera sanguinolenta*) usually occupies small tumours in the mucous lining of the stomach. The three-corner-headed strongle (*Dochmius trigonocephalus*) infests the intestinal canal. The wrinkled threadworm (*Trichosoma plica*) gains access to the bladder. The whip worm of the dog *Trichocephalus depressiusculus*) inhabits the cæcum. The spiral flesh

worm (*Trichina spiralis*) has frequently been reared both in the intestines and muscles by experiment. The blood infesting thread worm of Grube and Delafond (*Filaria hæmatica*) is probably a distinct species; and the same may possibly be said of Gescheidt's small nematode (*Filaria trispinulosa*) discovered in the eye. There are also the small thread worms found by Mr. T. Mather, V.S., in the liver ducts and substance of the gland, as well as in cysts within the walls of the intestines. Provisionally I find it convenient to recognise Mr. Mather's parasites under the distinctive and combined title of *Filaria hepatica*. It is a great pity none of the specimens were preserved, but my hope is that fresh examples may be discovered before very long.

Lastly, there is another canine hæmatozoon, the males, females, and embryos of which, according to Professor Leiserung, occur in the venous blood of certain parts of the body of the dog. The learned pathologist denominates this parasite *Hæmatozoon subulatum*. As the very general and generic term here employed is not likely to find acceptance with helminthologists; and as, moreover, Leiserung's figure and description of the male seems to connect the parasite with the strongyloid group of worms, I believe that the generic and specific title *Strongylus subulatus* will be found to be more appropriate.

I am indebted to Dr. Schliep, of the London German Hospital, for drawing my attention to Professor Leiserung's discovery and original paper on this subject, which is contained in Virchow's *Archiv*, for 1865; and, as I had no ready means of access to the journal, Dr. Schliep also obligingly furnished me with an abstract of the paper. Professor Leiserung, it seems, at first supposed that his minute subulate strongles were identical

with the hæmatozoa of Grube and Delafond; but he subsequently satisfied himself that this was an erroneous view of the case. He found these worms in two old dogs; and from the second dog he obtained living examples, which he succeeded in keeping alive for more than a week after the death of the host. The largest of the female worms did not exceed the 12th of an inch in length; and, commonly, from four to six full-grown parasites were found in a single drop of the venous blood from a particular part of the body. The free embryos gave an average length of $\frac{1}{108}''$ from head to tail.

CHAPTER X.

PARASITES OF THE DOG CONTINUED—IMPORTANCE OF THE STUDY OF THE CANINE CESTODES—THE CUCUMERINE TAPEWORM—ITS LARVÆ RESIDE IN THE LOUSE OF THE DOG—THE GID TAPEWORM—HOW DOGS BECOME INFESTED—PARASITIC DISEASES CAN BE EITHER PROMOTED OR CUT SHORT AT OUR PLEASURE—HOW TO INCREASE THE NUMBER OF TAPEWORMS AND BLADDER WORMS—THE MARGINED TAPEWORM—THE HYDATID PRODUCING TAPEWORM—SOURCE AND DEVELOPMENT EXPLAINED—EXTRAORDINARY PROVISION MADE FOR ITS PROPAGATION—RARITY OF THE ADULT PARASITE IN ENGLAND—THE LARVÆ ARE DESTRUCTIVE TO HUMAN LIFE—THE ENTOZOON FOUND BY DR. MADDOX.

ALTHOUGH the lumbricoid worms of the dog constitute an important section of the canine parasites, the practical interest attaching to them is scarcely so great as that which appertains to the tapeworms.

If, on the one hand, it be allowed that the canine cestodes are not so numerous as the nematodes, it must on the other hand be admitted that (as regards public health and the propagation of parasitic diseases amongst animals) the part these tapeworms are destined to play in the economy of life is not merely remarkable, but altogether unique.

The first cestode which I have to notice is the cucu-

merine tapeworm (*Tænia cucumerina*). This entozoon is so named because of the shape of its mature segments or proglottides. The latter are much elongated, narrowed at both ends, each joint being supplied with a pair of reproductive papillæ, one on either side of the margin. It is a delicate and almost transparent tapeworm, measuring from ten to twenty inches in length.

This parasite is very common in English dogs, and according to Krabbe infests 48 per cent. of the dogs in Denmark, and 57 per cent. of the dogs in Iceland. The animals infest themselves in a singular manner. The joints of the worm, having escaped *per anum*, readily crawl as semi-independent creatures on the coat of the dog, chiefly on the back and side. The eggs thus distributed are readily swallowed by the louse of the dog (*Trichodectes latus*).

In the body of the louse the six-hooked embryo, hitherto contained in the egg of the tapeworm, escapes the shell and becomes transformed into a minute cysticercus or louse-measle. When the dog is irritated by the lice, it attacks, bites, and frequently swallows the offending external parasite. In this way the louse-measle is transferred to the dog's intestinal canal, where, in course of time, it develops into the sexually mature cucumerine tapeworm.

Thus the mange-mite, or scab insect (as it is rather incorrectly termed) serves as the intermediary bearer of larval tapeworm, and forms an essential factor in the production of this particular species of cestode parasite. In this connection I may also remark that there is every reason to believe that, so far as the intermediary bearers are concerned, the tapeworms infesting herbivorous animals have a very similar origin.

The Gid Tapeworm.—The veterinarian and agriculturist are alike interested in the facts connected with the development of this parasite (*Tœnia cœnurus*). In the full-grown state this worm varies from twenty to fifty inches in length. It cannot be said to be common in this country, and probably does not occur in more than five per cent. of our dogs. In Iceland, however, as Dr. Krabbe has shown, it occurs in 18 per cent. of the native dogs. Its prevalence, no doubt, bears a strict correspondency to the amount of "gid disease" existing in any country.

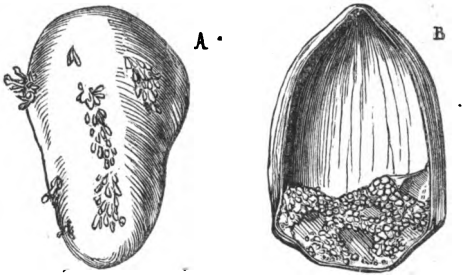

Fig. 19. Larvæ of the Gid Tapeworm.

In order to understand how the dog obtains this tapeworm, it must be observed that gid hydatids, or *cœnuri*, each represent a sort of colony of larval parasites. When, therefore, the dog eats a sheep's brain containing a single hydatid, he swallows a colony of larvæ, each of the latter being destined to become transformed into a tapeworm in the bowel. Thus, Fig. 19 represents two hydatids, one being viewed from without, and the other from within. At A the young tapeworm heads are seen projecting from the exterior surface of the hydatid; whilst at B they are seen retracted within the interior of the bladder

worm. There may be from three to five hundred of these heads projecting from the surface of a single gid hydatid. That each process does really represent the head of a young tapeworm is not only proved by the evidence derived from microscopic examination of the processes themselves, but also by the results of our worm-feeding experiments.

Professor Simonds and myself have repeatedly reared gid tapeworms from the gid hydatid; and those who are interested in the details of the method employed will find an acconut of the experiments in the fifth article of the supplement to my work on "Entozoa."

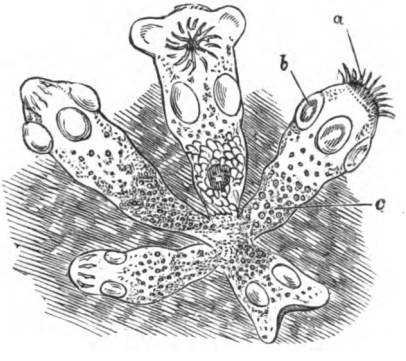

Fig. 20. Tapeworm-like Heads of the Gid Hydatid

If a small fragment of the gid hydatid with its characteristic processes be magnified about eighty diameters, all the more essential structures will be brought into view. As in the accompanying drawing (Fig. 20), such a demonstration may display a bunch of young tapeworm heads, one or all of them showing the crown of hooks (*a*), the four suckers (*b*), and a multitude of minute oval, calcareous

particles (*c*), which the old naturalists formerly supposed to be eggs. The common bladder vesicle from which the heads project exhibits cellular markings.

The above figures are copied from Numan's treatise, and I can testify to their perfect accuracy of detail. In one remarkable instance, recorded by Eichler, as many as 2000 heads were displayed by a single *cœnurus*.

It must be evident to any thinking person that the results thus obtained by scientific research are of the highest value, and so complete a knowledge as we now possess should place us in a position to utilise these results with practical advantage. In short, we can either increase or decrease the number of parasites and the diseases they create according to our desire. If a crop of these parasites could be shown to be beneficial, their production might be favoured by experiment to a practically illimitable extent; but, as no very obvious good, whilst much harm, is clearly traceable to their prevalence, it is manifestly our duty either to put a check upon their increase, or to obliterate them altogether. The question therefore is, "How shall we proceed?" The reply must be, "Destroy the tapeworms and their ova."

It is not sufficient that the sheep farmer should look closely after his flocks, guarding against the bad effects of excessive cold, wet pasture land, coarse fodder, and so forth. These precautions (admirable in themselves, and essential to the prevention of other maladies than the particular one in question) have no power in warding off epidemics of gid.

What the advocate of agricultural hygiene has to insist upon is the cutting off of the supply of those tapeworm eggs which, by their introduction into the fodder, form the sole cause of gid. To thrust this scientific conception

of cause and effect into the mind of the ordinary farmer is no easy matter; nevertheless, if such a truth could be generally realised and accepted, there would soon be an end not only to "gid," or turnside, but also to a whole host of parasitic diseases, the nature of which, in consequence of our helminthological researches, ought now to be thoroughly well understood by intelligent agriculturists.

In this connection it should be sufficient to state one great result of all our experimental endeavours, leaving the precise mode of dealing with the question, practically, to the persons chiefly interested. In this view, therefore, I do not hesitate to put forth the following general statement or proposition: "The propagation of entozoa in general, and of tapeworms in particular, is intimately connected with, and absolutely dependent upon, the promiscuous association of different kinds of animals; and, as regards the production of parasitism amongst domesticated animals used as food, it is perfectly certain that the tapeworms of the dog play a most conspicuous part."

As I have elsewhere remarked, it is not sufficient that the sheep owner and grazier should look after the welfare of his flocks and herds in the ordinary and direct manner adverted to; but he must see that no dog, either belonging to himself or his neighbours, is permitted to go about the land distributing the eggs of tapeworms with every act of defæcation, as well as by dropping the ova off its coat.

If a dog harbouring tapeworms be allowed to plunge into an ordinary field pond to wash himself, such an act conveys numerous eggs into the water; and the next herbivorous animal that comes to slake its thirst will be liable to drink in one or more of the parasite's eggs. If

thus the hogget or a calf swallows the egg of a gid tapeworm, turnside will be the consequence; but if the herbivore swallows the eggs of the hydatid tapeworm, properly so called, hydatids will be the result. And so on, with other creatures which happen to ingest the ova of different and appropriate parasites.

To hares and rabbits the dog thus communicates another bladder-worm disease; and we ourselves are also liable to become infested with hydatids from the same source.

All these evils may be readily overcome, if the advice have offered be duly acted upon.

To be sure, neither the helminthologist, nor any other true man of science, need personally reckon upon any adequate return for sacrifices of time made in the interests of the public good; nevertheless, when abundant light has been thrown upon points of great practical importance, it is a legitimate prerogative on the part of the scientist to demand that the results of his labours shall be utilised for the benefit of others.

The largest tapeworm liable to reside in the dog is a parasite chiefly derived from the sheep; that is to say, the sheep acts as the principal intermediary bearer of the larval cestode, which latter acquires tapeworm-maturity when it is taken into the stomach and intestines of the dog along with flesh-food. The entozoon in question is the margined tapeworm.

This worm (*Tænia marginata*) reaches a length of from five to eight feet. It is an abundant species, occurring probably in fully 25 per cent. of English dogs that are not less than one year old. In Denmark it occurs in 14 per cent.; and in Iceland, according to Krabbe, in no less than 75 per cent. of the native dogs.

I have elsewhere characterised the larva of this parasite as the Slender-necked Hydatid (*The Field*, Feb. 22, 1873). The accompanying illustration, from the learned Pastor Goeze's work, shows the hydatid (*Cysticercus tenuicollis*) of the natural size at A (Fig. 21); whilst the letter B represents a magnified view of the head, displaying the suckers and double crown of hooks.

Artificial rearing of the *Tœnia marginata* in the dog has frequently been accomplished abroad, and Mr. Simonds and myself have been equally successful in our experiments with this worm at the Royal Veterinary College.

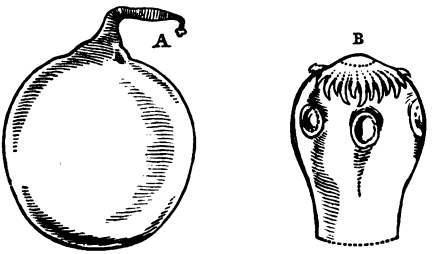

Fig. 21. Larva of the Margined Tapeworm.

The Hydatid Tapeworm.—Of all the entozoa infesting mankind and animals, the little *Tœnia echinococcus* is one of the most remarkable; and the facts of development which render the parasite so interesting to the helminthologist have an intimate bearing upon questions of general and agricultural hygiene. The larvæ form the common hydatids or bladder worms of veterinarians (*Echinococcus veterinorum*).

As in the dog the full-grown tapeworm only reaches the third of an inch in length, it is difficult for the non-

professional man to realise the fact that the same entozoon in its larval or vesicular state attains a size many thousand times exceeding that of the parasite in its adult condition.

Harmless when full-grown, it is fearfully destructive to life in the juvenile stages of growth. To be sure, its bad effects are chiefly witnessed in the human subject; but

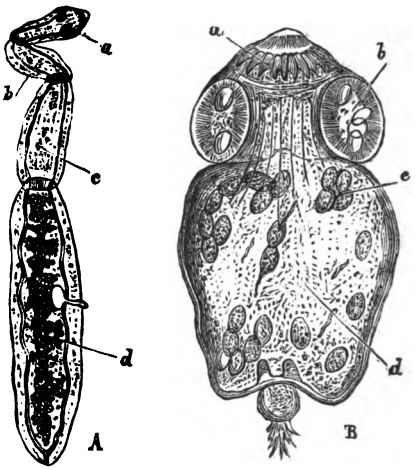

Fig. 22. Hydatid Tapeworm and Echinococcus-Head

cattle, sheep, horses, and swine occasionally perish from the presence of the larvæ within their vital organs.

If it be asked how all this mischief is brought about, the briefest answer suffices to explain the matter practically. The herbivorous animals and ourselves get the echinococcus disease by swallowing the eggs of the hydatid tapeworm.

Here is a representation of the parasite (Fig. 22, A). It exhibits the head segment with its four suckers and

crown of hooks (*a*), and three ordinary segments (*b*, *c*, *d*), the lowermost of which is sexually mature, displaying numerous eggs internally. Water vessels traverse the entire length of the worm.

One of the strangest points connected with this entozoon is the extraordinary provision made for its propagation. In ordinary cases one tapeworm only results from the growth of the products of a single egg; but here we may have thousands of tapeworms all resulting from a solitary germ.

I must explain briefly.

Eggs escape from the dog *per anum*. One swallowed by any herbivorous animal, say a sheep, will (by a lengthened process of development, the details of which I need not give) eventuate in the formation of hydatids. These hydatids, under favourable circumstances, will by internal budding produce innumerable heads or scolices (Fig. 22, B), each of which displays the tænia-like crown of hooks (*a*), the suckers (*b*), the calcareous particles (*c*), and a vesicular body (*d*).

When, therefore, a dog is fed on the viscera of a sheep containing perfect hydatids of this description, all the numerous heads become developed into tapeworms in the animal's intestines. This has been proved over and over again by experiment.

Most of the heads are developed in delicate sacs, termed brood-capsules, one of which is here represented in the collapsed or broken-up state (Fig. 23). It will be further seen that the seven attached heads have their respective crowns of hooks inverted and concealed within the vesicular body; and their appearance in this condition strikingly contrasts with that displayed by the single echinococcus head figured above.

These illustrations are reduced copies from figures given in my general treatise on the Entozoa.

It is a fortunate circumstance that this destructive little tapeworm is comparatively rare in England. It is the smallest cestode infesting the dog, and the one most likely to be overlooked.

Every year, notwithstanding its rarity, this little canine entozoon, by means of its larvæ, claims the lives

Fig. 23. Group of Echinococcus-Heads

of scores, or it may be hundreds, of persons in this country; but, with all England's wealth, I do not suppose a dozen people could be found who would be prepared to sacrifice a few pounds each for the purpose of promoting an investigation, the results of which would be eminently conducive to public health, and most certainly help to diminish our annual mortality. At the same time such a research would inevitably tend to lessen the amount of, if it did not altogether put an end to

at least one frequent form of parasitism affecting our domesticated animals.

Six years ago I pointed out the desirability of promoting an inquiry of this character; and independently, both as regards trouble and expense, I undertook a series of first steps towards its consummation. Here the matter rests; since I do not feel called upon to sacrifice every personal resource at my command in order to complete an investigation, the probable beneficial results of which are, naturally enough, neither comprehended by the public nor duly appreciated by the sanitarian.

NOTE.—Since the previous sheets went to press I have received Dr. Maddox's paper "On an Entozoon with Ova, found encysted in the Muscles of a Sheep," which is published, with an excellent plate, in the June number of *The Monthly Microscopical Journal* (p. 245). The structure of the mutton measle is thus further elucidated; but, as before remarked, the Author is evidently wrong in supposing that the larval cestode in question contains eggs. In other respects the details he gives are both important and interesting.

CHAPTER XI.

PARASITES OF THE DOG CONTINUED—HOW HARRIERS AND GREYHOUNDS BECOME INFESTED WITH TAPEWORM—DEATH FROM PENTASTOMES IN THE AIR PASSAGES — TRUE NATURE OF THE SO-CALLED MAW-WORMS EXPLAINED—SUITABLE TREATMENT—PARASITES OF THE HORSE—WHY SO LITTLE REGARDED BY VETERINARIANS—ENUMERATION OF EQUINE ENTOZOA—THE PALISADE WORM—PRODUCES ANEURISM IN THE HORSE AND ASS—HISTORY OF ITS DEVELOPMENT—A SIMPLE MEANS OF DIAGNOSIS—LITERATURE OF EQUINE PARASITISM—ITS IMPORTANCE IN RELATION TO HYGIENE—INTERESTING CASES OF WANDERING OF THE ARMED STRONGLE—WORM IN THE EYE.

SPORTSMEN who care for the welfare of their dogs should never allow these animals to devour the entrails of hares captured in the field. In the county of Norfolk I have myself witnessed this piece of carelessness on the part of keepers, and have ventured to remonstrate accordingly.

Almost every hare (and the same may be said of full-grown rabbits) harbours within its abdominal cavity a larval parasite (*Cysticercus pisiformis*) which, when swallowed by the dog, becomes transformed into a tapeworm, varying from two to three feet in length (*Tœnia serrata*).

I have many times reared this cestode entozoon by experiment. In harriers and greyhounds the serrated tapeworm is very abundant, but in other dogs it is com-

paratively rare. This parasite is little known in Denmark, and it appears to be altogether wanting in Iceland. In France and Germany it is probably of much less common occurrence than in this country.

Of the remaining internal parasites infesting the dog, I need only allude to several species and varieties of pit-headed tapeworm (*Bothriocephalus latus, B. cordatus, B. fuscus, B. reticulatus,* and *B. dubius*); since, so far as I

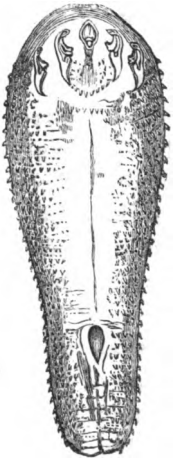

Fig. 24. Larval Pentastome.

am aware, only the first-named has been recognised as a canine entozoon in England.

I must not omit to mention thearichnidan parasite (*Pentastoma tœmoides*), which, as already stated, is the adult representative of the *Pentastoma denticulatum* residing in the viscera of the horse, as well as in the internal organs of ruminants (Fig. 24). The illustration is from Küchenmeister. In the full-grown state this

creature dwells in the nasal and frontal sinuses; our dogs commonly obtaining the worm by frequenting butchers' stalls and slaughterhouses, where portions of the fresh viscera are apt to be inconsiderately flung to hungry animals.

One of the most interesting cases ever published (where suspicions of dog poisoning had been unwarrantably entertained) shows that even death itself may result from the presence of the pentastome. It was recorded by Professor Dick, in the *Veterinarian* for 1840 (p. 42).

A fine and healthy dog died suddenly; and after death, in place of discovering mercury, arsenic, or some one of the other metallic poisons which were carefully sought for, Mr. Dick detected three pentastomes. They had evidently produced the fatal result by wandering from the nasal chambers downwards—one lodging in the larynx, one in the trachea, and the third in the left bronchus.

As these singular parasites appreciate warmth, I have no doubt that the cold air of the winter's morning (on which the dog was taken out by the keeper) caused the downward migration of the pentastomes, thereby also producing the fatal suffocation.

When writing on this subject in *The Field*, a friend called my attention to the circumstance that I had omitted to speak of the so-called common maw-worms, continually seen on the fæces of dogs in kennels, in the streets, and elsewhere. It is only right, therefore, that I should mention that these white, vermiform, disgusting looking parasites were described by the late Mr. Youatt as independent species of Ascarides, and he confounded them with examples of the *Ascaris vermicularis*, so

common in the human subject. They are also described in the work by "Stonehenge" on the "Management of Dogs" (p. 15). I must therefore particularly explain that these misnamed maw-worms are merely the semi-independent segments or proglottides of two of the larger species of tapeworm which infest the dog, namely, *Tœnia marginata* and *Tœnia serrata*.

It follows, therefore, that the treatment for this common kennel worm is the same as that for the tapeworm, seeing that it is only a cast-off portion of the self-same entozoon. Areca-nut powder is the best remedy; but male fern may be sometimes substituted with advantage.

I may add that when santonine is employed for any of the round worms, it should always be combined with a purgative if it is to prove effective. For this purpose nothing is ordinarily better than castor-oil; but twenty or thirty grains of aloes may be employed instead of the oil in obstinate cases. In the latter case a few grains of ginger should be added to prevent griping.

Parasites of the Horse.—Although the parasites of the horse and ass are sufficiently numerous as species, their importance in relation to disease in these animals is, speaking generally, far less than that which obtains in the case of other domesticated animals similarly affected.

Herein lies the reason why so few veterinarians think the study of the entozoa worthy of their regard. If questioned, they would perhaps say, in effect: The tapeworms of the horse (*Tœnia mammillana, T. perfoliata,* and *T. plicata*) are insignificant as regards size (Fig. 25; altered from Goeze), and the symptoms they create are of little or no consequence. The large round worms (*Ascaris megalocephala*), though occasionally present in great

numbers, are readily got rid of by doses of aloes. The flukes (*Fasciola hepatica*) are too unimportant and rare to merit attention. As to the strongles which give rise to aneurisms in old horses and donkeys (*Strongylus armatus*), no doubt they are sometimes the cause of death, but the amount of mortality from this source is exceedingly trifling. The sharp-tailed threadworms, or maw-worms (*Oxyuris curvula*) certainly may occasion

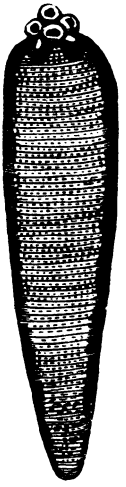

Fig. 25. PERFOLIATE TAPEWORM.

considerable irritation within the larger bowel, but we can easily expel them with purgatives. The worm in the eye (*Filaria papillosa*) is confined to tropical countries; and, moreover, the inconvenience it creates is readily cured by its removal. Lastly, it is almost superfluous to mention the occurrence of the gid hydatid (*Cœnurus cerebralis*) and other forms of cestode larvæ (*Cysticercus*

fistularis), since the assistance of the veterinary practitioner is rarely demanded for the treatment of the disorders they produce.

If the above summary may be regarded as a tolerably correct interpretation of the views commonly held by the leading members of the veterinary profession, it must be allowed that there is a great deal of sound inference in the statement.

It assuredly does so happen that bad forms of parasitism in the horse are comparatively rare; and this I take to be due, not so much to the alleged innocuousness of the individual parasites themselves, as to the circumstance that horses are, as a rule, much more closely looked after, in a sanitary sense, than most other animals. The scrupulous cleanliness observed in all large stables is eminently destructive to the welfare of parasites, and the large proportion of dry and artificially-prepared fodder consumed by horses leaves little opportunity for the transference of the ova of cestodes and nematodes, which require a certain amount of moisture for their preservation in the free condition. Moreover, the drinking water supplied to horses is, generally speaking, tolerably pure.

To the foregoing list of equine parasites some others have to be added. Thus, the *Filaria lachrymalis* infests various parts of the body, and also sometimes the eye itself. The *Spiroptera megastoma* and *Spiroptera microstoma* occupy the stomach; the former worm occurring in small swellings beneath the mucuous membrane, whilst the latter lies free in the cavity. The *Onchocerca reticulata* encysts itself within various tissues; whilst three additional species of strongle (*Strongylus gigas*, *S. micrurus*, and *S. tetracanthus*) respectively

invade the kidney, the bronchi, and the large intestine.

Several larval nematodes have also been described, but their precise genetic relations are at present only imperfectly known.

It will naturally be expected that I should say something more respecting the habits and development of the palisade worm (*Strongylus armatus*). This is the entozoon which produces the so-called worm aneurism in the horse, and still more frequently in the ass.

Its natural history has long remained a puzzle to veterinarians, and even now all the phases of its life-cycle are not perfectly understood by the helminthologist. We know enough, however, to enable us to correct many errors currently entertained, and also sufficient to guide us towards a correct interpretation of the stranger phenomena associated with the wanderings of this interesting nematode. Thus, the worm as it is commonly found in the blood vessels is constantly spoken of as a variety of the species in question, whereas the *Strongylus armatus minor*, as it is termed, is only the same parasite in a sexually immature condition. The illustration (Fig. 26) represents a number of these worms lodged in the mesenteric artery of an ass.

What we know of the development of this parasite is chiefly due to the researches of Professor Rudolf Leuckart.

As obtains in the case of one of the sheep's strongles (*S. hypostomus*), it appears that the embryos are not developed within their eggs until the latter have been expelled and lodged within moist mud. Here the so-called rhabditiform young, or larvæ, will change their first skin in about three weeks, and at the same time part with

their tails; but it would seem that before they finally gain access to the horse they must enter the body of some intermediary bearer, and finally be swallowed by the ultimate host along with drink or green fodder.

In all likelihood their next active wanderings are the immediate cause of the formation of the aneurisms, from whence, by means of a very complicated mouth-arma-

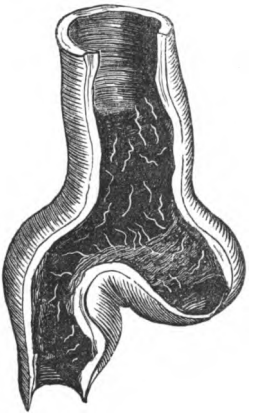

Fig. 26. Palisade Worms in a Blood Vessel.

ture, acting like a file and trephine, they subsequently bore their way into the intestinal canal, in which situation they at length acquire full growth and sexual maturity.

As this worm belongs to the dung-feeding division of the nematodes, there is no difficulty in recognising with the naked eye through the transparent skin the dark-coloured contents of the intestine. In the female parasite this excrementitious matter sometimes forms little pellets or masses incrusted around the anal aperture; and these

excretions, when examined microscopically, will be found to consists principally of vegetable debris.

As I have elsewhere shown, the vegetable nature of the intestinal contents of the maw-worm or pin-worm of the horse (*Oxyuris curvula*) was well known to Dujardin; and as regards these troublesome parasites, I may further observe that their eggs are capable of forming yellow-coloured incrustation masses at the verge of the rectum of the horse. Such external agglutinations afford sure evidence of the existence of intestinal worms; therefore, as a simple means of diagnosis, they should not be overlooked by the practical veterinarian.

If any person doubts the importance of a knowledge of parasites in reference to agricultural and hygienic matters, I would suggest to him the propriety of taking the trouble to wade through the extended and widely-scattered literature of parasitism as it affects domesticated animals in general and the horse in particular.

Although I have spent some months in this instructive occupation, I have not attempted, in this record, to do more than refer to a few of the practical papers written by veterinarians; because, as a rule, purely professional notices of the character described are chiefly valuable as showing the extent of parasitism, and the many ways in which the entozoa prove either injurious or fatal to their bearers.

As regards the horse, I have already explained why professional men think so little of the parasites which attack this animal; nevertheless, I cannot dismiss this section of my subject without calling attention to a few interesting cases showing the necessity for a more thorough knowledge of the entozoa of the horse by professional men.

One of the most instructive papers on the prevalence of ascarides in horses is that by Mr. G. Boddington, who, writing some years back, says that ever since the commencement of his professional duties, near Cardiff, he "has been called upon, almost without intermission, to prescribe for horses suffering from worms" (*Veterinarian*, 1859, p. 375). His treatment by means of aloes, in combination with sulphate of iron, appears to have been eminently successful; four, five, and even six hundred of the large lumbricoids coming away in particular instances.

In the present work I have not space to give either the details or full references to other useful papers on the lumbricoids of the horse; but the various cases and observations recorded by Messrs. Anderson, Litt, Moir, Percivall, Poulton, and Tyndal, in the same periodical, are particularly noteworthy.

The wanderings of the armed strongle frequently prove injurious, being occasionally fatal to the host. In young colts they are especially liable to make their way into the scrotum, or into its glandular contents, and when lying within or upon the peritoneum they not unfrequently produce ascites. Cases of this description have often been observed by Professor Simonds, and instances are likewise recorded and commented on by Messrs. Aitken, Clancy, Wright, the late Dr. Baird, and others.

A characteristic example of death from this source is given by Mr. Meyrick, of Welshpool (*Veterinarian* for 1859, p. 695). Many additional fatal cases from nematodes in the horse might be adduced; some being the result of the action of one species of parasite and some of another.

In this category of lesions may also be placed those

arising from bots. The development of these parasites, however, I do not here propose to describe, as they do not properly belong to the helminths or intestinal worms. Most interesting cases of this kind, several of them proving fatal, are recorded in the *Veterinarian* by Messrs. Brewer, Cartwright, Goodworth, Mather, and Woods.

As to the literature of the palisade strongle, that is well nigh inexhaustible. In this country papers have been contributed on the latter subject by Harlan, Mercer, Seaman, and others; whilst abroad, the writings of Gurlt, Rayer, and Leuckart have chiefly helped to fashion our knowledge of the structure and development of the entozoon. On this subject I cannot give further details, but I may mention that the most complete memoir I have yet seen is that by Dr. Bollinger (*"Die Kolik der Pferde, und das Wurmaneurysma der Eingeweidearterien;"* Munchen, 1870).

The literature of "worm in the eye" is equally co-extensive with the foregoing, as may be gathered from the memoirs of Clarkson, Hopkinson, Jeffreson, Hickman, Kennedy, Macnamara, Molyneux, Percival, Skeavington, Twining, and many others.

For a good example of the parasite I am indebted to the Rev. Horace Waller, the well-known Zambesi traveller; the specimen, a male, having been forwarded from Assam.

Lastly, I have only to add that there are many other curious examples of equine parasitism on record, the precise nature of which—from the total absence of any knowledge of the merest rudiments of helminthology on the part of the various writers—must necessarily remain involved in obscurity.

CHAPTER XII.

INTERNAL PARASITES OF THE HOG—THE PORK-TAPEWORM NOT SO COMMON AS THE BEEF-TAPEWORM — MEASLY PORK—CYSTICERCI IN WESTPHALIAN HAMS—THE CROWN-TAILED STRONGLE—THOUSANDS OF SWINE ARE INFESTED BY THE STEPHANURUS— ITS ORIGINAL DISCOVERY IN BRAZIL—OCCURS IN THE UNITED STATES AND IN AUSTRALIA—ENTERPRISE OF THE PUBLIC PRESS IN THE CAUSE OF PARASITISM CONSIDERED AS USEFUL KNOWLEDGE—THE SPIRAL FLESHWORM, OR TRICHINA—ENGLISH OUTBREAK OF TRICHINIASIS — DEVELOPMENT OF THE FLESHWORM — OTHER PARASITES FOUND IN SWINE—ENTOZOA OF THE CAT—LUMBRICOID WORMS OF THE CAT—TRICHINIASIS AND OLULANIASIS COMPARED—TAPEWORMS OF THE CAT—CONCLUSION.

"OF all animals, feral or domestic, the common pig is beyond doubt the most fertile source of human entozoa; at least, of important parasites, the *Trichina spiralis* and the tapeworm would, there is good reason to believe, cease to infect us, did not this favourite quadruped act the part of a communicating medium."

Thus wrote an eminent biologist in the pages of the *Natural History Review* for 1865; but, seen in the light of recent discoveries, the statement he advanced is by no means correct.

The tapeworm alluded to is the *Tænia solium*, and my

investigations have long since shown that this cestode parasite is not nearly so common in England as the *Tænia mediocanellata*, which, as before remarked, Leuckart and myself have experimentally proven to be derived from eating beef; and as regards the *Trichina*, many other animals than swine are liable to be infested by it, though, doubtless, human bearers have hitherto infected themselves with this entozoon principally, if not exclusively, by the consumption of underdone pork. The expression "this favourite quadruped" clearly refers to the preference given to swine's flesh as human food, and not to the animal itself.

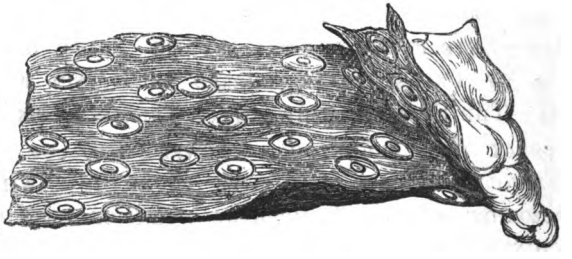

Fig. 27. Measles or Cysticerci in Pork.

My object in prefixing these remarks is mainly for the purpose of counteracting the popular and very erroneous notion that, in the matter of parasitism, pork is more productive of tapeworm than any other kind of meat. Measly pork should certainly be avoided as unfit for human food, unless thoroughly well cooked; yet I have known a family to partake of a measled ham when the latter was infested to an extent that had produced a thoroughly disgusting and spawn-like appearance.

Such a diseased portion was that sent to me by Dr.

Prior, taken from a purchased Westphalian ham, and which I have elsewhere described. Here is represented an equally characteristic fragment of uncooked measly pork, taken from an old sow, and forwarded to me for examination by Dr. Dobie, of Chester (Fig. 27). From this small and thin slice of meat I removed no less than thirty-three measles. As is now well-known, these small bladder-worms or larval cestodes are the sexually immature offspring of the *Tænia solium*, which, as a tape-worm, has at present only been found in the human bearer.

Decidedly one of the most important parasites of swine is the *Stephanurus dentatus*, or, as we may call it, the crown-tailed strongle. From specimens of a worm forwarded to me by Dr. Fletcher, of Indiana, I had the satisfaction of identifying its true character. When first discovered in the United States, it was supposed to be new to science, and was accordingly described by Professor Verrill under the name of *Sclerostoma pinguicola*. In the pages of the *British Medical Journal* for January 14, 1872, I announced the discovery, and subsequently gave a more lengthened description of the entozoon in *Nature*. Strange to say, I also shortly afterwards detected this parasite amongst a batch of worms sent for identification from Australia; so that it appears quite certain that the geographical range of this parasite is co-extensive with that of the hog in its domesticated state. At present, however, it has not been seen in Europe, though doubtless we shall sooner or later discover it.

Thousands of hogs are infested by this nematode, which takes up its abode in the abdominal viscera, and especially in the fatty tissues surrounding these organs. The

original discovery of this worm in a Chinese variety of hog was made by Dr. Natterer at Barra do Rio Negro, Brazil, on the 24th of March, 1834.

In the American States a very large proportion of the hogs not only harbour this entozoon, but also the common lung-strongle. I believe Dr. Fletcher brought the important subject of hog parasitism before the United States National Swine Breeders' Association, which met at Indianopolis last November (1872), and I can only express regret that so little attention is paid to this and other kindred subjects in England, where many wealthy agricultural societies are known to be in existence.

All enterprise and enthusiasm in the cause of parasitism appears to be delegated to the proprietors of the public press; and it must be allowed that, in the interests of others rather than themselves, they have often commenced a useful work which, but for their initiative, would never have been undertaken.

Those who care to acquaint themselves with the facts connected with the discovery of this remarkable worm (*Stephanurus dentatus*) will find fuller references in my review of Krabbe's recent memoir on the entozoa of domesticated animals (*Husdyrenes Indvoldsorme; loc. cit.*), given in the *London Medical Record* for April 2, 1873, and reprinted in the *Veterinarian* of the following month.

The spiral fleshworm is the little parasite which of all other entozoa has acquired most notoriety. Whilst, however, epidemics produced by the *Trichina spiralis* are of frequent occurrence on the Continent, they have been almost entirely unknown to the inhabitants of this island. One such outbreak occurred in Cumberland in the spring of 1871, the full particulars of which I have

given in my Cantor Lectures (*Journal of the Society of Arts*, 1871).

In this place I deem it unnecessary to recapitulate the facts of fleshworm parasitism at any great length. In the hog, as our experiments at the Royal Veterinary College freely demonstrated, these worms do not appear to be capable of occasioning inconvenience to the bearer; at least, the pig, in which I reckoned we reared some sixteen millions of encysted muscle-trichinæ, never showed the slightest indications of suffering. In other animals, however, as well as in man, this immunity from symptoms of irritation is seldom preserved under like circumstances.

Stating the matter in the briefest possible terms, we may say that the *Trichina* requires about three weeks to run its course of development, commencing and ending with the encysted condition in which it was originally discovered. This is the state here represented from one of Professor Pagenstecher's admirable illustrations (Fig. 28). The ingestion of muscle-trichinæ by any suitable bearer ensures the completion of the adult growth of the worm in the intestine of the host in two days. In six days more the embryos will commence to leave the body of the female worm, and immediately set about penetrating the walls of the intestine, in order to arrive at their destination in the most direct manner available. Having at length wandered into and secured a resting-place within those voluntary muscles which are well supplied with connective tissue, they will (after the further expiration of fourteen days from the time they commenced their migration) eventually have acquired the well-known form and size of the perfected muscle-trichina.

The so-called lemon-shaped, or oval cysts, in which the

muscle flesh-worms are commonly found enclosed, are not essential to the perfection of the larval parasite; but they commence to form immediately the young worms have attained the highest degree of organisation characteristic of their larval growth.

Having so often written on the subject of Trichina, I have purposely limited my remarks in the present work; but in case the reader should desire further particulars, I

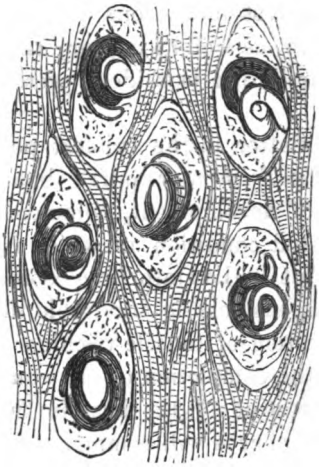

Fig. 28. Encysted Fleshworms or Muscle-Trichinæ.

take the opportunity of referring to the 12th chapter of my larger illustrated treatise on the entozoa. In the supplement to that work I have also given an exhaustive account of the history of the discovery of this remarkable parasite. I have likewise added many additional particulars of interest in my Lectures on Practical Helminthology (p. 122), in the Cantor Lectures

already referred to, and in other places as indicated in the separate bibliographies of the works just mentioned.

Were it not for the really sensational, and therefore to some extent offensive, title, I might also with pleasure refer to an anonymous pamphlet by an M.R.C.S., vulgarly entitled "How about Pork?—Startling Revelations!" It contains some useful information; but the author studiously ignores the researches of English helminthologists, and writes in a style which is anything but creditable to him. By far the best memoirs on Trichina which have appeared in England are the two written by Drs. Thudichum and Althaus respectively. For full references to these and other works on the same subject I must, however, refer to the bibliography of my general treatise.

Besides the three forms of entozoa above mentioned, the hog harbours a variety of other interesting parasites.

The flukes (*Fasciola hepatica* and *Distoma lanceolatum*) only very rarely occur, and, so far as I am aware, tapeworms, as such, have never been found in swine; but for this loss they make up their share of guests by harbouring two kinds of bladder-worms (*Cysticercus tenuicollis* and *Echinococcus veterinorum*).

As already hinted, the nematodes are largely represented; for, in addition to the *Trichina* and *Stephanurus*, we find the common round worm (*Ascaris lumbricoides*), several strongyloid worms (*Sclerostoma dentatum, Spiroptera strongylina*, and *Strongylus paradoxus*), and also two other more or less closely allied nematodes (*Trichocephalus crenatus* and *Simondsia paradoxa*).

In addition to these there is one other remarkable parasite (*Echinorhynchus gigas*), which, though fortunately not of frequent occurrence in this country, is nevertheless

of high interest to the helminthologist, as being the only thorn-headed or acanthocephalous worm liable to infest our domesticated animals. The full-grown female has been known to acquire a length of 18in., the thickness of the body equalling that of the little finger. The males seldom measure more than 3in. from head to tail. This worm, when present in any considerable numbers, quickly reduces the strength of the porcine host, occasionally causing death by perforation of the bowel.

Parasites of the Cat.—So many persons are interested in the welfare of this useful house-pet, that I am constrained to say a few words respecting its internal parasites, several of which it shares in common with the dog.

Every owner of cats must have, from time to time, noticed the frequent occurrence of sickness amongst these animals; such fits of vomiting usually terminating in the expulsion of worms from the mouth. The entozoa causing these attacks are small lumbricoids, or nematodes (*Ascaris mystax*) occupying the stomach; the females being nearly twice as long as the males, and sometimes measuring as much as four inches. In the dog, as we have seen, a variety of the same worm grows to the length of half a foot. It may also be added that five or six cases are on record of the occurrence of this parasite in the human body.

Respecting other nematodes infesting the cat, I may notice a species of strongle (*Dochmius tubæformis*) occasionally found in the upper intestine, and also the flesh-worm (*Trichina spiralis*), which has frequently been reared in this animal by experiment.

In the wild progenitor of our domestic cat the presence of two other nematodes has also been pointed

out (*Trichosoma cati*, and *Cheiracanthus robustus*); but the most important of all the feline nematodes is a little worm, first described by Prof. Leuckart. This is the *Olulanus tricuspis*.

Whilst the full-grown *Olulanus* only measures about the 1-25th of an inch, its embryos are, for so small a creature, of almost gigantic size. The adult worm resides in the lining membrane of the stomach. The young of this parasite, like *Trichinæ*, are apt to migrate within the body of the feline host. They thus become encysted within the lungs and liver; but not in any other of the visceral organs. I have seen tens of thousands of them occupying the lungs; the infested animal perishing in consequence of the inflammatory action set up by their presence.

A certain number of the embryos of *Olulanus* escape by the bowel of the host. These when swallowed by mice become encysted within the little rodents' muscles, very much after the fashion of *Trichinæ*; so that one may say the mice become olulanised in the same way that we say people or animals become trichinised. All this has been experimentally proved by Leuckart, who fed a cat with olulanised mouse-flesh, and afterwards found the escaped young in the cat's alimentary canal. As, however, these encapsuled *Olulani* from the mouse had not become sufficiently advanced in their larval organisation, Leuckart did not succeed in rearing the sexually mature parasite in the feline stomach, but there could be no doubt as to the ultimate destiny of the encapsuled young.

If we include the wild host, five species of tapeworm have been described as infesting the cat. One of these (*Tænia crassicollis*), which is common to both the tame

and wild animal, is obtained by the cat from eating the livers of rats and mice, in which organ the larvæ of the parasite reside in their bladder-worm state (*Cysticercus fasciolaris*).

Of the remaining four tapeworms, the *Tænia lineata* is found only in the wild animal, and its distinctiveness as a species is not well established; whilst the *Bothriocephalus decipiens* is extremely rare, and only known in the house cat. The most common of all the species is the *Tænia elliptica*, which is generally considered to be identical with, or at best a mere variety of, the cucumerine tapeworm of the dog. There can therefore be little question that the louse of the cat plays the part of intermediary bearer, by harbouring the measle properly belonging to the elliptical variety of tape-worm.

The only other cestode is the *Tænia litterata*, which is found in Iceland; but, according to Krabbe, it is not so common in the cat as in the dog. He calls it the *Tænia canis lagopodis*; and I may mention that very recently I obtained evidence that this tapeworm is liable to infest the cheetah. I had, however, long previously received the parasite for identification from Professor Murie of Edinburgh—during the period of his official connection with the Zoological Society's Menagerie, Regent's-park.

The only other internal worms requiring to be noticed are the flukes (*Distoma lanceolatum, Amphistoma truncatum*, and *Hemistoma cordatum*), all of which, together with the larval pentastome (*Pentastoma denticulatum*), are of comparatively rare occurrence in the feline host.

The external parasites are not less numerous, as species, than the internal worms; but the veterinary practitioner is comparatively rarely called upon to treat the disorders occasioned by their presence.

At some future time I hope to write a companion manual treating of the external parasites of our domesticated animals.

In conclusion, it only remains for me to express the hope that this very much condensed outline of the forms of internal parasites and the phenomena of parasitism occurring amongst our domesticated animals may prove a useful *point d'appui* for the furtherance of a study which, in its singular revelations of hitherto unsuspected causes and effects, has already thrown much light upon the nature of a variety of diseases affecting alike ourselves and the brute creation.

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